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**UTILITY PATENT APPLICATION  
FOR  
ANTAGONISTS OF MCP-1 FUNCTION AND METHODS OF USE  
THEREOF**

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## ANTAGONISTS OF MCP-1 FUNCTION AND METHODS OF USE THEREOF

### CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a divisional of Application No. 10/106,881, filed 25 March 2002, which claims the priority under 35 USC 119(e) of US Provisional Application No. 60/281,274, filed 3 April 2001. The entire contents of both of those applications are incorporated by reference.

### FIELD OF THE INVENTION

[0002] The present invention relates to chemical compounds, pharmaceutical compositions comprising said compounds, uses of said compounds and compositions, methods of treatment employing said compounds and compositions, and processes for preparing said compounds. Specifically, this invention relates to novel compounds which are antagonists of Monocyte Chemoattractant Protein-1 (MCP-1) function and are useful in the prevention or treatment of chronic or acute inflammatory or autoimmune diseases, especially those associated with aberrant lymphocyte or monocyte accumulation such as arthritis, asthma, atherosclerosis, diabetic nephropathy, inflammatory bowel disease, Crohn's disease, multiple sclerosis, nephritis, pancreatitis, pulmonary fibrosis, psoriasis, restenosis, and transplant rejection. More specifically, the invention is related to pharmaceutical compositions comprising these compounds and the use of these compounds and compositions in the prevention or treatment of such diseases.

### BACKGROUND OF THE INVENTION

#### **Chemokines: Structure and Function**

[0003] The migration of leukocytes from blood vessels into diseased tissues is an important process in the initiation of normal inflammatory responses to certain stimuli or insults to the immune system. However, this process is also involved in the onset and progression of life-threatening inflammatory and autoimmune diseases; blocking leukocyte recruitment in these disease states, therefore, can be an effective therapeutic strategy.

[0004] The mechanism by which leukocytes leave the bloodstream and accumulate at inflammatory sites involves three distinct steps: (1) rolling, (2) arrest and firm adhesion, and (3) transendothelial migration [Springer, *Nature* 346:425-433 (1990); Lawrence and Springer, *Cell* 65:859-873 (1991); Butcher, *Cell* 67:1033-1036 (1991)]. The second step is mediated at the molecular

level by chemoattractant receptors on the surface of leukocytes which bind chemoattractant cytokines secreted by proinflammatory cells at the site of damage or infection. Receptor binding activates leukocytes, increases their adhesiveness to the endothelium, and promotes their transmigration into the affected tissue, where they can secrete inflammatory and chemoattractant cytokines and degradative proteases that act on the subendothelial matrix, facilitating the migration of additional leukocytes to the site of injury.

[0005] The chemoattractant cytokines, collectively known as “chemokines,” are a large family of low molecular weight (8 to 10 kD) proteins that share the ability to stimulate directed cell migration (“chemotaxis”) [Schall, *Cytokine* 3:165-183 (1991); Murphy, *Rev Immun* 12:593-633 (1994)].

[0006] Chemokines are characterized by the presence of four conserved cysteine residues and are grouped into two main subfamilies based on whether the two amino-terminal cysteines are separated by one amino acid (CXC subfamily, also known as  $\alpha$ -chemokines) or immediately adjacent to each other (CC subfamily, also referred to as  $\beta$ -chemokines) [Baggiolini et al., *Adv Immunol* 55:97-179 (1994); Baggiolini et al., *Annu Rev Immunol* 15:675-705 (1997); Deng et al., *Nature* 381:661-666 (1996); Luster, *New Engl J Med* 338:436-445 (1998); Saunders and Tarby, *Drug Discovery Today* 4:80-92 (1999)].

[0007] The chemokines of the CXC subfamily, represented by IL-8, are produced by a wide range of cells and act predominantly on neutrophils as mediators of acute inflammation. The CC chemokines, which include MCP-1, RANTES, MIP-1 $\alpha$ , and MIP-1 $\beta$ , are also produced by a variety of cells, but these molecules act mainly on monocytes and lymphocytes in chronic inflammation.

[0008] Like many cytokines and growth factors, chemokines utilize both high and low affinity interactions to elicit full biological activity. Studies performed with labeled ligands have identified chemokine binding sites (“receptors”) on the surface of neutrophils, monocytes, T cells, and eosinophils with affinities in the 500 pM to 10 nM range [Kelvin et al., *J Leukoc Biol* 54:604-612 (1993); Murphy, *Annu Rev Immunol* 12:593-633 (1994); Raport et al., *J Leukoc Biol* 59:18-23 (1996); Premack and Schall, *Nature Med* 2:1174-1178 (1996)]. The cloning of these receptors has revealed that cell surface high-affinity chemokine receptors belong to the seven transmembrane (“serpentine”) G-protein-coupled receptor (GPCR) superfamily.

[0009] Chemokine receptors are expressed on different cell types, including non-leukocyte cells. Some receptors are restricted to certain cells (eg, the CXCR1 receptor is predominantly restricted to neutrophils), whereas others are more widely expressed (eg, the CCR2 receptor is expressed on monocytes, T cells, natural killer cells, dendritic cells, and basophils).

[0010] Given that at least twice as many chemokines have been reported to date as there are receptors, there is a high degree of redundancy in the ligands and, not surprisingly, most chemokine receptors are rather promiscuous with regard to their binding partners. For example, both MIP-1 $\alpha$  and RANTES bind to the CCR1 and CCR5 receptors, while IL-8 binds to the CXCR1 and CXCR2 receptors. Although most chemokines receptors bind more than one chemokine, CC receptors bind only CC chemokines, and CXC receptors bind only CXC chemokines. This ligand-receptor restriction may be related to the structural differences between CC and CXC chemokines, which have similar primary, secondary, and tertiary structures, but different quaternary structures [Lodi et al., *Science* 263:1762-1767 (1994)].

[0011] The binding of chemokines to their serpentine receptors is transduced into a variety of biochemical and physiological changes, including inhibition of cAMP synthesis, stimulation of cytosolic calcium influx, upregulation or activation of adhesion proteins, receptor desensitization and internalization, and cytoskeletal rearrangements leading to chemotaxis [Vaddi et al., *J Immunol* 153:4721-4732 (1994); Szabo et al., *Eur J Immunol* 27:1061-1068 (1997); Campbell et al., *Science* 279:381-384 (1998); Aragay et al., *Proc Natl Acad Sci USA* 95:2985-2990 (1998); Franci et al., *J Immunol* 157:5606-5612 (1996); Aramori et al., *EMBO J* 16:4606-4616 (1997); Haribabu et al., *J Biol Chem* 272:28726-28731 (1997); Newton et al., *Methods Enzymol* 287:174-186 (1997)]. In the case of macrophages and neutrophils, chemokine binding also triggers cellular activation, resulting in lysosomal enzyme release and generation of toxic products from the respiratory burst [Newton et al., *Methods Enzymol* 287:174-186 (1997); Zachariae et al., *J Exp Med* 171:2177-2182 (1990); Vaddi et al., *J Leukocyte Biol* 55:756-762 (1994)]. The molecular details of the chemokine-receptor interactions responsible for inducing signal transduction, as well as the specific pathways that link binding to the above mentioned physiological changes, are still being elucidated. Notwithstanding the complexity of these events, it has been shown that in the case of the MCP-1/CCR2 interaction, specific molecular features of MCP-1 can induce different conformations in CCR2 that are coupled to separate post-receptor pathways [Jarnagin et al., *Biochemistry* 38:16167-16177 (1999)]. Thus, it

should be possible to identify ligands that inhibit chemotaxis without affecting other signaling events.

[0012] In addition to their high-affinity seven transmembrane GPCRs, chemokines of both subfamilies bind to various extracellular matrix proteins such as the glycosaminoglycans (GAGs) heparin, chondroitin sulfate, heparan sulfate, and dermatan sulfate with affinities in the middle nanomolar to millimolar range. These low-affinity chemokine-GAG interactions are believed to be critical not only for conformational activation of the ligands and presentation to their high-affinity serpentine receptors, but also for the induction of stable chemokine gradients that may function to stimulate haptotaxis (*i.e.*, the migration of specific cell subtypes in response to a ligand gradient that is affixed upon the surface of endothelial cells or embedded within the extracellular matrix) [Witt and Lander, *Curr Biol* 4:394-400 (1994); Rot, *Eur J Immunol* 23:303-306 (1993); Webb et al., *Proc Natl Acad Sci USA* 90:7158-7162 (1993); Tanaka et al., *Nature* 361:79-82 (1993); Gilat et al., *J Immunol* 153:4899-4906 (1994)]. Similar ligand-GAG interactions have been described for a variety of cytokines and growth factors, including the various members of the FGF family, hepatocyte growth factor, IL-3 and IL-7, GM-CSF, and VEGF [Roberts et al., *Nature* 332:376-378 (1988); Gilat et al., *Immunol Today* 17:16-20 (1996); Clarke et al., *Cytokine* 7:325-330 (1995); Miao et al., *J Biol Chem* 271:4879-4886 (1996); Vlodavsky et al., *Cancer Metastasis Rev* 15:177-186 (1996)].

#### MCP-1 and Diseases

[0013] Chemokines have been implicated as important mediators of allergic, inflammatory and autoimmune disorders and diseases, such as asthma, atherosclerosis, glomerulonephritis, pancreatitis, restenosis, rheumatoid arthritis, diabetic nephropathy, pulmonary fibrosis, multiple sclerosis, and transplant rejection. Accordingly, it has been postulated that the use of antagonists of chemokine function may help reverse or halt the progression of these disorders and diseases.

[0014] In particular, elevated expression of MCP-1 has been observed in a number of chronic inflammatory diseases [Proost et al., *Int J Clin Lab Res* 26:211-223 (1996); Taub, D. D. *Cytokine Growth Factor Rev* 7:355-376 (1996)] including, but not limited to, rheumatoid arthritis [Robinson et al., *Clin Exp Immunol* 101:398-407 (1995); Hosaka et al., *ibid.* 97:451-457 (1994); Koch et al., *J Clin Invest* 90:772-779 (1992); Villiger et al., *J Immunol* 149:722-727 (1992)], asthma [Hsieh et al., *J Allergy Clin Immunol* 98:580-587 (1996); Alam et al., *Am J Respir Crit Care Med* 153:1398-1404

(1996); Kurashima et al., *J Leukocyte Biol* 59:313-316 (1996); Sugiyama et al., *Eur Respir J* 8:1084-1090 (1995)], and atherosclerosis [Yla-Herttuala et al., *Proc Natl Acad Sci USA* 88:5252-5256 (1991); Nelken et al., *J Clin Invest* 88:1121-1127 (1991)].

[0015] MCP-1 appears to play a significant role during the early stages of allergic responses because of its ability to induce mast cell activation and LTC<sub>4</sub> release into the airway, which directly induces AHR (airways hyper-responsiveness) [Campbell et al., *J Immunol* 163:2160-2167 (1999)].

[0016] MCP-1 has been found in the lungs of patients with idiopathic pulmonary fibrosis and is thought to be responsible for the influx of mononuclear phagocytes and the production of growth factors that stimulate mesenchymal cells and subsequent fibrosis [Antoniades et al., *Proc Natl Acad Sci USA* 89:5371-5375 (1992)]. In addition, MCP-1 is also involved in the accumulation of monocytes in pleural effusions which is associated with both *Mycobacterium tuberculosis* infection and malignancy [Strieter et al., *J Lab Clin Med* 123:183-197 (1994)].

[0017] MCP-1 has also been shown to be constitutively expressed by synovial fibroblasts from rheumatoid arthritis patients, and its levels are higher in rheumatoid arthritis joints compared to normal joints or those from other arthritic diseases [Koch et al., *J Clin Invest* 90:772-779 (1992)]. These elevated levels of MCP-1 are probably responsible for the monocyte infiltration into the synovial tissue. Increased levels of synovial MIP-1 $\alpha$  and RANTES have also been detected in patients with rheumatoid arthritis [Kundel et al., *J Leukocyte Biol* 59:6-12 (1996)].

[0018] MCP-1 also plays a critical role in the initiation and development of atherosclerotic lesions. MCP-1 is responsible for the recruitment of monocytes into atherosclerotic areas, as shown by immunohistochemistry of macrophage-rich arterial wall [Yla-Herttuala et al., *Proc Natl Acad Sci USA* 88:5252-5256 (1991); Nelken et al., *J Clin Invest* 88:1121-1127 (1991)] and anti-MCP-1 antibody detection [Takeya et al., *Human Pathol* 24:534-539 (1993)]. LDL-receptor/MCP-1-deficient and apoB-transgenic/MCP-1-deficient mice show significantly less lipid deposition and macrophage accumulation throughout their aortas compared with wild-type MCP-1 strains [Alcami et al., *J Immunol* 160:624-633 (1998); Gosling et al., *J Clin Invest* 103:773-778 (1999); Gu et al., *Mol. Cell* 2:275-281 (1998); Boring et al., *Nature* 394:894-897 (1998)].

[0019] Other inflammatory diseases marked by specific site elevations of MCP-1 include multiple sclerosis (MS), glomerulonephritis, and stroke.

[0020] These findings suggest that the discovery of compounds that block MCP-1 activity would be beneficial in treating inflammatory diseases.

### **Antagonists of Chemokine Function**

[0021] Most chemokine antagonists reported to date are either neutralizing antibodies to specific chemokines or receptor-ligand antagonists, that is, agents that compete with specific chemokines for binding to their cognate serpentine receptors but, unlike the chemokines themselves, do not activate these receptors towards eliciting a functional response [Howard et al., *Trend Biotechnol* 14:46-51 (1996)].

[0022] The use of specific anti-chemokine antibodies has been shown to curtail inflammation in a number of animal models (eg, anti-MIP-1 $\alpha$  in bleomycin- induced pulmonary fibrosis [Smith et al., *Leukocyte Biol* 57:782-787 (1994)]; anti-IL-8 in reperfusion injury [Sekido et al., *Nature* 365:654-657 (1995)], and anti-MCP-1 in a rat model of glomerulonephritis [Wada et al., *FASEB J* 10:1418-1425 (1996)]). In the MRL-*lpr* mouse arthritis model, administration of an MCP-1 antagonist significantly reduced the overall histopathological score after the early onset of the disease [Gong et al., *J Exp Med* 186:131-137 (1997)].

[0023] A major problem associated with using antibodies to antagonize chemokine function is that they must be humanized before use in chronic human diseases. Furthermore, the ability of multiple chemokines to bind and activate a single receptor forces the development of a multiple antibody strategy or the use of cross-reactive antibodies in order to completely block or prevent pathological conditions.

[0024] Several small molecule antagonists of chemokine receptor function have been reported in the scientific and patent literature [White, *J. Biol Chem* 273:10095-10098 (1998); Hesselgesser, *J. Biol Chem* 273:15687-15692 (1998); Bright et al., *Bioorg Med Chem Lett* 8:771-774 (1998); Lapierre, *26th Natl Med Chem Symposium*, June 14-18, Richmond (VA), USA (1998); Forbes et al., *Bioorg Med Chem Lett* 10:1803-18064 (2000); Kato et al., WO Patent 97/24325; Shiota et al.,



WO Patent 97/44329; Naya et al., WO Patent 98/04554; Takeda Industries, JP Patent 0955572 (1998); Schwender et al., WO Patent 98/02151; Hagmann et al., WO Patent 98/27815; Connor et al., WO Patent 98/06703; Wellington et al., US Patent 6,288,103 B1 (2001)].

[0025] The specificity of the chemokine receptor antagonists, however, suggests that inflammatory disorders characterized by multiple or redundant chemokine expression profiles will be relatively more refractory to treatment by these agents.

[0026] A different approach to target chemokine function would involve the use of compounds that disrupt the chemokine-GAG interaction. One class of such agents with potential therapeutic application would consist of small organic molecules that bind to the chemokine low affinity GAG-binding domain.

[0027] Compounds of this class might not inhibit binding of the chemokine to its high-affinity receptor *per se*, but would disrupt chemokine localization within the extracellular matrix and provide an effective block for directed leukocyte-taxis within tissues. An advantage of this strategy is the fact that most CC and CXC chemokines possess similar C-terminal protein folding domains that define the GAG-binding site, and, hence, such compounds would be more useful for the treatment of inflammatory disorders induced by multiple, functionally redundant chemokines [McFadden and Kelvin, *Biochem Pharmacol* 54:1271-1280 (1997)].

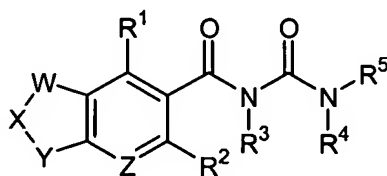
[0028] The use of small molecule drugs to bind cytokine ligands and disrupt interactions with extracellular GAGs has been reported with FGF-dependent angiogenesis [Folkman and Shing, *Adv Exp Med Biol* 313:355-364 (1992)]. For example, the heparinoids suramin and pentosan polysulphate both inhibit angiogenesis under conditions where heparin is either ineffective or even stimulatory [Wellstein and Czubyko, *Breast Cancer Res Treat* 38:109-119 (1996)]. In the case of suramin, the anti-angiogenic capacity of the drug has also been shown to be targeted against VEGF [Waltenberger et al., *J Mol Cell Cardiol* 28:1523-1529 (1996)] which, like FGF, possesses heparin-binding domains similar to those of the chemokines. Heparin or heparin sulphate has also been shown to directly compete for GAG interactions critical for T-cell adhesion mediated by MIP-1 $\beta$  *in vitro* [Tanaka et al., *Nature* 361:79-82 (1993)].

[0029] The entire disclosure of all documents cited throughout this application are incorporated herein by reference.

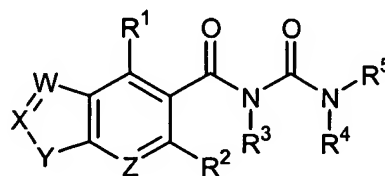
### SUMMARY OF THE INVENTION

[0030] The present invention relates to compounds that inhibit MCP-1-induced chemotaxis of human monocytic cells both *in vitro* and *in vivo*. These novel MCP-1 antagonists are useful for the treatment of inflammatory diseases, especially those associated with lymphocyte and/or monocyte accumulation, such as atherosclerosis, diabetic nephropathy, inflammatory bowel disease, Crohn's disease, multiple sclerosis, nephritis, pancreatitis, pulmonary fibrosis, psoriasis, restenosis, rheumatoid arthritis, and other chronic or acute autoimmune disorders. In addition, these compounds can be used in the treatment of allergic hypersensitivity disorders, such as asthma and allergic rhinitis, characterized by basophil activation and eosinophil recruitment.

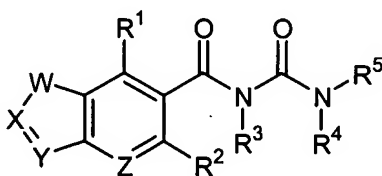
[0031] A first embodiment of the present invention provides compounds of Formula I, Formula II, and Formula III:



I



II



III

where:

(A) In Formula I:

each of W, X and Y is independently selected from CR<sup>6</sup>R<sup>7</sup>, N-R<sup>7</sup>, O, or S provided that at least one of W, X, and Y is a non-carbon ring atom, and at least one of W, X, and Y is a carbon ring atom.

(B) In Formula II:

W and X are independently selected from C-R<sup>6</sup> and N, and Y is selected from CR<sup>6</sup>R<sup>7</sup>, N-R<sup>7</sup>, O, or S, provided that:

- (i) at least one of W, X, and Y is a non-carbon ring atom, and
- (ii) when W is C-R<sup>6</sup> and X is N, then Y is CR<sup>6</sup>R<sup>7</sup>.

(C) In Formula III:

W is selected from CR<sup>6</sup>R<sup>7</sup>, N-R<sup>7</sup>, O, or S, and X and Y are independently selected from C-R<sup>6</sup> and N, provided that:

- (i) at least one of W, X, and Y is a non-carbon ring atom, and
- (ii) when X is N and Y is C-R<sup>6</sup>, then W is CR<sup>6</sup>R<sup>7</sup>;

and where:

Z is N or C-R<sup>8</sup>;

each R<sup>1</sup>, R<sup>2</sup>, R<sup>6</sup>, and R<sup>8</sup> is independently, hydrogen, optionally substituted lower alkyl, alkenyl, alkynyl, cycloalkyl, cycloalkyl(lower alkyl), optionally substituted heterocycloalkyl, optionally substituted aryl, optionally substituted heteroaryl, optionally substituted aryl(lower alkyl), halo(lower alkyl), -CF<sub>3</sub>, halogen, nitro, -CN, -OR<sup>9</sup>, -SR<sup>9</sup>, -NR<sup>9</sup>R<sup>10</sup>, -NR<sup>9</sup>(carboxy(lower alkyl)), -C(=O)R<sup>9</sup>, -C(=O)OR<sup>9</sup>, -C(=O)NR<sup>9</sup>R<sup>10</sup>, -OC(=O)R<sup>9</sup>, -SO<sub>2</sub>R<sup>9</sup>, -OSO<sub>2</sub>R<sup>9</sup>, -SO<sub>2</sub>NR<sup>9</sup>R<sup>10</sup>, -NR<sup>9</sup>SO<sub>2</sub>R<sup>10</sup> or -NR<sup>9</sup>C(=O)R<sup>10</sup>, where R<sup>9</sup> and R<sup>10</sup> are independently, hydrogen, optionally substituted lower alkyl, lower alkyl-N(C<sub>1-2</sub> alkyl)<sub>2</sub>, lower alkyl(optionally substituted heterocycloalkyl), alkenyl, alkynyl, optionally substituted cycloalkyl, cycloalkyl(lower alkyl), optionally substituted heterocycloalkyl(lower alkyl), aryl(lower alkyl), optionally substituted aryl, optionally substituted heteroaryl, heteroaryl(lower alkyl), or R<sup>9</sup> and R<sup>10</sup> together are -(CH<sub>2</sub>)<sub>4-6</sub>- optionally interrupted by one O, S, NH, N-(aryl), N-(aryl(lower alkyl)), N-(carboxy(lower alkyl)) or N-(optionally substituted C<sub>1-2</sub> alkyl) group,

R<sup>3</sup> and R<sup>4</sup> are independently, hydrogen, lower alkyl, optionally substituted lower alkyl, optionally substituted aryl, or optionally substituted aryl(lower alkyl), or, together, are -(CH<sub>2</sub>)<sub>2-4</sub>-

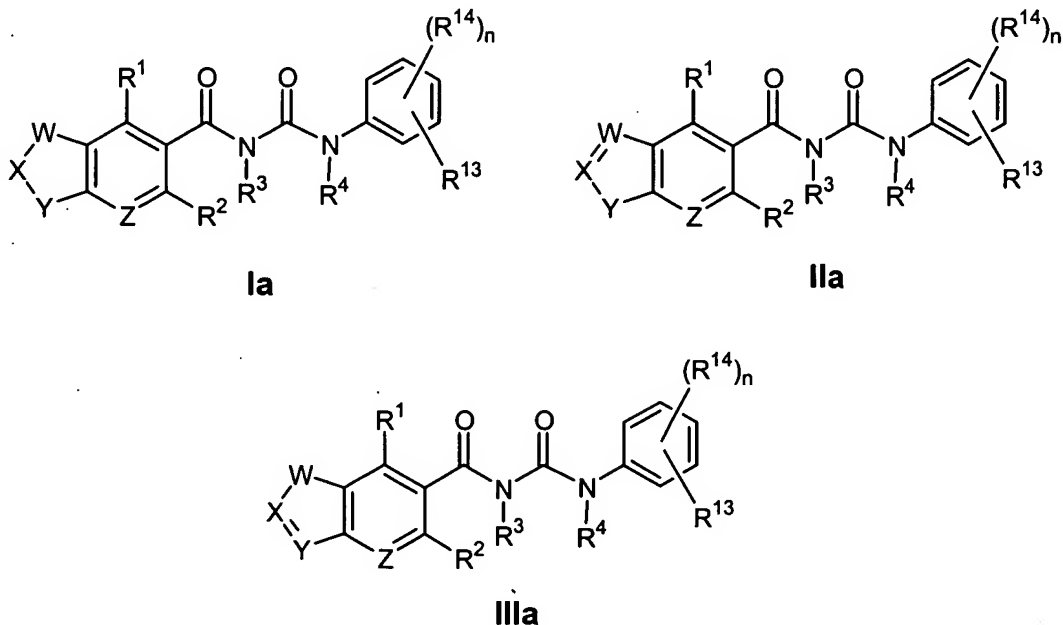
R<sup>5</sup> is hydrogen, optionally substituted lower alkyl, alkenyl, alkynyl, cycloalkyl, cycloalkyl(lower alkyl), optionally substituted heterocycloalkyl, optionally substituted aryl, optionally substituted aryl(lower alkyl), optionally substituted heteroaryl, optionally substituted heteroaryl(lower alkyl), -C(=O)R<sup>11</sup>, -C(=O)OR<sup>11</sup>, -C(=O)NR<sup>11</sup>R<sup>12</sup>, -SO<sub>2</sub>R<sup>11</sup>, or -SO<sub>2</sub>NR<sup>11</sup>R<sup>12</sup>, where R<sup>11</sup> and R<sup>12</sup> are independently, hydrogen, optionally substituted lower alkyl, alkenyl, alkynyl, cycloalkyl,

cycloalkyl(lower alkyl), aryl, optionally substituted heteroaryl, heteroaryl(lower alkyl), or  $R^{11}$  and  $R^{12}$  together are  $-(CH_2)_{4-6}-$ ,

each  $R^7$  is hydrogen, optionally substituted lower alkyl, alkenyl, alkynyl, cycloalkyl, cycloalkyl(lower alkyl), optionally substituted heterocycloalkyl, optionally substituted aryl, optionally substituted heteroaryl, optionally substituted aryl(lower alkyl),  $-C(=O)R^9$ ,  $-C(=O)OR^9$ ,  $-C(=O)NR^9R^{10}$ ,  $-SO_2R^9$ , or  $-SO_2NR^9R^{10}$ , where  $R^9$  and  $R^{10}$  are independently, hydrogen, optionally substituted lower alkyl, lower alkyl- $N(C_{1-2} \text{ alkyl})_2$ , lower alkyl(optionally substituted heterocycloalkyl), alkenyl, alkynyl, optionally substituted cycloalkyl, cycloalkyl(lower alkyl), optionally substituted heterocycloalkyl(lower alkyl), aryl(lower alkyl), optionally substituted aryl, optionally substituted heteroaryl, heteroaryl(lower alkyl), or  $R^9$  and  $R^{10}$  together are  $-(CH_2)_{4-6}-$  optionally interrupted by one O, S, NH, N-(aryl), N-(aryl(lower alkyl)), N-(carboxy(lower alkyl)) or N-(optionally substituted  $C_{1-2}$  alkyl) group, or the pharmaceutically acceptable salts thereof, optionally in the form of single stereoisomers or mixtures of stereoisomers thereof.

[0032] The compounds of this invention may possess one or more chiral centers, and can therefore be produced as individual stereoisomers or as mixtures of stereoisomers, depending on whether individual stereoisomers or mixtures of stereoisomers of the starting materials are used. In addition, some of the compounds of the invention are capable of further forming pharmaceutically acceptable salts and esters. The compounds of this invention may further exist in tautomeric forms and can therefore be produced as individual tautomeric forms or as mixtures of tautomeric forms. Unless indicated otherwise, the description or naming of a compound or groups of compounds is intended to include both the individual isomers or mixtures (racemic or otherwise) of stereoisomers and their tautomeric forms. Methods for the determination of stereochemistry and the separation of stereoisomers are well known to a person of ordinary skill in the art [see the discussion in Chapter 4 of March J.: *Advanced Organic Chemistry*, 4th ed. John Wiley and Sons, New York, NY, 1992]. All of these stereoisomers and pharmaceutical forms are intended to be included within the scope of the present invention.

[0033] A second embodiment of the present invention provides compounds of Formula Ia, Formula IIa, and Formula IIIa:



where:

(A) In Formula Ia:

each of W, X and Y is independently selected from  $\text{CR}^6\text{R}^7$ ,  $\text{N-R}^7$ , O, or S provided that at least one of W, X, and Y is a non-carbon ring atom, and at least one of W, X, and Y is a carbon ring atom.

(B) In Formula IIa:

W and X are independently selected from  $\text{C-R}^6$  and N, and Y is selected from  $\text{CR}^6\text{R}^7$ ,  $\text{N-R}^7$ , O, or S, provided that:

- (i) at least one of W, X, and Y is a non-carbon ring atom, and
- (ii) when W is  $\text{C-R}^6$  and X is N, then Y is  $\text{CR}^6\text{R}^7$ .

(C) In Formula IIIa:

W is selected from  $\text{CR}^6\text{R}^7$ ,  $\text{N-R}^7$ , O, or S, and X and Y are independently selected from  $\text{C-R}^6$  and N, provided that:

- (i) at least one of W, X, and Y is a non-carbon ring atom, and
- (ii) when X is N and Y is  $\text{C-R}^6$ , then W is  $\text{CR}^6\text{R}^7$ ;

and where:

Z is N or C-R<sup>8</sup>;

R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup>, R<sup>6</sup>, R<sup>7</sup>, and R<sup>8</sup> are as defined in the first embodiment,

R<sup>13</sup> is hydrogen, optionally substituted lower alkyl, alkenyl, alkynyl, cycloalkyl, cycloalkyl(lower alkyl), heterocycloalkyl, optionally substituted aryl, optionally substituted aryl(lower alkyl), optionally substituted heteroaryl, optionally substituted heteroaryl(lower alkyl), halo(lower alkyl), -CF<sub>3</sub>, halo(lower alkyl), halogen, nitro, -CN, -OR<sup>15</sup>, -SR<sup>15</sup>, -NR<sup>15</sup>R<sup>16</sup>, -C(=O)R<sup>15</sup>, -C(=O)OR<sup>15</sup>, -C(=O)NR<sup>15</sup>R<sup>16</sup>, -OC(=O)R<sup>15</sup>, -SO<sub>2</sub>R<sup>15</sup>, -SO<sub>2</sub>NR<sup>15</sup>R<sup>16</sup>, -NR<sup>15</sup>SO<sub>2</sub>R<sup>16</sup> or -NR<sup>15</sup>C(=O)R<sup>16</sup>, where R<sup>15</sup> and R<sup>16</sup> are independently, hydrogen, optionally substituted lower alkyl, alkenyl, alkynyl, -CF<sub>3</sub>, cycloalkyl, optionally substituted heterocycloalkyl, cycloalkyl(lower alkyl), optionally substituted aryl, optionally substituted heteroaryl, optionally substituted heteroaryl(lower alkyl) or, together, are -(CH<sub>2</sub>)<sub>4-6</sub>- optionally interrupted by one O, S, NH or N-(C<sub>1-2</sub> alkyl) group,

each R<sup>14</sup> is independently selected from optionally substituted lower alkyl, optionally substituted aryl, optionally substituted heteroaryl, hydroxy, halogen, -CF<sub>3</sub>, -OR<sup>17</sup>, -NR<sup>17</sup>R<sup>18</sup>, -C(=O)R<sup>17</sup>, -C(=O)OR<sup>17</sup>, -O(CH<sub>2</sub>)<sub>m</sub>C(=O)OR<sup>17</sup>, where m is an integer of 1 to 4, or -C(=O)NR<sup>17</sup>R<sup>18</sup>, where R<sup>17</sup> and R<sup>18</sup> are independently, hydrogen, lower alkyl, alkenyl, alkynyl, -CF<sub>3</sub>, optionally substituted heterocycloalkyl, cycloalkyl, cycloalkyl(lower alkyl), optionally substituted aryl, heteroaryl, heteroaryl(lower alkyl) or, together, are -(CH<sub>2</sub>)<sub>4-6</sub>-, optionally interrupted by one O, S, NH or N-(C<sub>1-2</sub> alkyl) group, and

n is an integer of 0 to 4,

or the pharmaceutically acceptable salts thereof, optionally in the form of single stereoisomers or mixtures of stereoisomers thereof.

[0034] Within this invention, certain compounds are preferred. Such preferred compounds are:

1. compounds of Formula I or Ia where W and Y are O, X is CR<sup>6</sup>R<sup>7</sup>, where R<sup>6</sup> and R<sup>7</sup> are independently hydrogen, lower alkyl, or optionally substituted aryl, and Z is C-H; or
2. compounds of Formula II or IIa where W is N, X is CR<sup>6</sup>, where R<sup>6</sup> is hydrogen, lower alkyl, or optionally substituted aryl, Y is O, and Z is C-H; or
3. compounds of Formula III or IIIa where W is O, X is CR<sup>6</sup>, where R<sup>6</sup> is hydrogen, lower alkyl, or optionally substituted aryl, Y is N, and Z is C-H; or

4. compounds of Formula III or IIIa where W is N-R<sup>7</sup>, where R<sup>7</sup> is hydrogen, lower alkyl, substituted lower alkyl, or optionally substituted aryl(lower alkyl), X and Y are each CR<sup>6</sup>, where R<sup>6</sup> is hydrogen, lower alkyl, or optionally substituted aryl, and Z is C-H; or
5. compounds of Formula II or IIa where W and X are each CR<sup>6</sup>, where R<sup>6</sup> is hydrogen, lower alkyl, or optionally substituted aryl, Y is N-R<sup>7</sup>, where R<sup>7</sup> is hydrogen, lower alkyl, substituted lower alkyl, or optionally substituted aryl(lower alkyl), and Z is C-H; or
6. compounds of Formula II or IIa, where W and X are each N, Y is N-R<sup>7</sup>, where R<sup>7</sup> is hydrogen, lower alkyl, substituted lower alkyl, or optionally substituted aryl(lower alkyl), and Z is C-H; or
7. compounds of Formula I or Ia where W and X are each CR<sup>6</sup>R<sup>7</sup>, where R<sup>6</sup> and R<sup>7</sup> are independently hydrogen, lower alkyl, or optionally substituted aryl, Y is O, and Z is C-H; or
8. compounds of Formula I or Ia, where W is O, X and Y are each CR<sup>6</sup>R<sup>7</sup>, where R<sup>6</sup> and R<sup>7</sup> are independently hydrogen, lower alkyl, or optionally substituted aryl, and Z is C-H; or
9. compounds of Formula II or IIa where W is N, X is CR<sup>6</sup>, where R<sup>6</sup> is hydrogen, lower alkyl, or optionally substituted aryl, Y is N-R<sup>7</sup>, where R<sup>7</sup> is hydrogen, lower alkyl, substituted lower alkyl, or optionally substituted aryl(lower alkyl), and Z is C-H; or
10. compounds of Formula III or IIIa where W is N-R<sup>7</sup>, where R<sup>7</sup> is hydrogen, lower alkyl, substituted lower alkyl, or optionally substituted aryl(lower alkyl), X is CR<sup>6</sup>, where R<sup>6</sup> is hydrogen, lower alkyl, or optionally substituted aryl, Y is N, and Z is C-H; or
11. compounds of Formula III or IIIa where W is N-R<sup>7</sup>, where R<sup>7</sup> is hydrogen, lower alkyl, substituted lower alkyl, or optionally substituted aryl(lower alkyl), X and Y are each N, and Z is C-H; or
12. compounds of the first and second embodiments where R<sup>1</sup> and R<sup>2</sup> are independently selected from hydrogen, lower alkyl, halogen, optionally lower alkyl substituted heterocycloalkyl, -OR<sup>9</sup>, -SR<sup>9</sup>, or -NR<sup>9</sup>R<sup>10</sup>, where R<sup>9</sup> and R<sup>10</sup> are hydrogen, lower alkyl or optionally substituted aryl; and/or
13. compounds of the first and second embodiments where R<sup>3</sup> and R<sup>4</sup> are independently selected from hydrogen or lower alkyl; or
14. compounds of Formula I or Ia where W and X are each CR<sup>6</sup>R<sup>7</sup>, where R<sup>6</sup> and R<sup>7</sup> are independently hydrogen, lower alkyl, or optionally substituted aryl, and Z is N-R<sup>7</sup>; or

15. compounds of Formula I or Ia where W is  $CR^6R^7$ , where  $R^6$  and  $R^7$  are independently hydrogen, lower alkyl, or optionally substituted aryl, X is O, and Z is  $N-R^7$ ; or
16. compounds of Formula I or Ia where W is O, X is  $CR^6R^7$ , where  $R^6$  and  $R^7$  are independently hydrogen, lower alkyl, or optionally substituted aryl, and Z is  $N-R^7$ .

[0035] Compounds of the second embodiment are preferred. Within the second embodiment, preferred compounds are those where:

1.  $R^{13}$  is independently selected from optionally substituted aryl, optionally substituted heteroaryl, halogen,  $-CF_3$ ,  $-CN$ ,  $-OR^{15}$ ,  $-C(=O)R^{15}$ ,  $-C(=O)OR^{15}$ , or  $-C(=O)NR^{15}R^{16}$ , where  $R^{15}$  and  $R^{16}$  are independently, hydrogen, lower alkyl, halo(lower alkyl), optionally substituted aryl, optionally substituted heteroaryl, heteroaryl(lower alkyl) or  $R^{15}$  and  $R^{16}$  together are  $-(CH_2)_{4-6}$ , optionally interrupted by one O, S, NH or  $N-(C_{1-2} \text{ alkyl})$  group, such as piperazinyl, 4-methylpiperazin-1-yl, morpholyl, hexahydropyrimidyl, and the like; and/or
2. each  $R^{14}$  is independently selected from halogen,  $-CF_3$ ,  $-OR^{17}$ ,  $-C(=O)OR^{17}$ ,  $-O(CH_2)_mC(=O)OR^{17}$ , where m is an integer of 1 to 4, or  $-C(=O)NR^{17}R^{18}$ , where  $R^{17}$  and  $R^{18}$  are independently, hydrogen, lower alkyl, optionally substituted aryl, heteroaryl, or heteroaryl(lower alkyl), or  $R^{17}$  and  $R^{18}$  together are  $-(CH_2)_{4-6}$ , optionally interrupted by one O, S, NH or  $N-(C_{1-2} \text{ alkyl})$  group, such as piperazinyl, 4-methylpiperazin-1-yl, morpholyl, and the like.

[0036] A number of different preferences have been given above, and following any one of these preferences results in a compound of this invention that is more presently preferred than a compound in which that particular preference is not followed. However, these preferences are generally independent [although preferences 1-11 above are mutually exclusive], and additive; and following more than one of these preferences may result in a more presently preferred compound than one in which fewer of the preferences are followed.

[0037] A third embodiment of the present invention provides pharmaceutical compositions comprising a pharmaceutically acceptable excipient and a therapeutically effective amount of at least one compound of this invention.

[0038] A fourth embodiment of the present invention provides methods for treating diseases treatable by administration of an MCP-1 inhibitor, for example, chronic or acute



inflammatory or autoimmune diseases such as asthma, atherosclerosis, diabetic nephropathy, glomerulonephritis, inflammatory bowel disease, Crohn's disease, multiple sclerosis, pancreatitis, pulmonary fibrosis, psoriasis, restenosis, rheumatoid arthritis, or a transplant rejection in mammals in need thereof, comprising the administration to such mammal of a therapeutically effective amount of at least one compound of this invention or a pharmaceutically acceptable salt thereof or a pharmaceutical composition comprising the same.

[0039] A fifth embodiment of this invention provides processes for the preparation of the compounds of the invention and the pharmaceutically acceptable salts thereof.

[0040] A sixth embodiment of this invention provides uses of the compounds of the invention in the preparation of medicaments for the treatment of chronic or acute inflammatory or autoimmune diseases such as asthma, atherosclerosis, diabetic nephropathy, glomerulonephritis, inflammatory bowel disease, Crohn's disease, multiple sclerosis, pancreatitis, pulmonary fibrosis, psoriasis, restenosis, rheumatoid arthritis, or a transplant rejection.

## DETAILED DESCRIPTION OF THE INVENTION

### Definitions and General Parameters

[0041] The following definitions apply to the description of compounds of the present invention:

[0042] "Alkyl" is a linear or branched saturated hydrocarbon radical having from 1 to 20 carbon atoms. Examples of alkyl radicals are: methyl, ethyl, n-propyl, isopropyl, n-butyl, isobutyl, sec-butyl, tert-butyl, n-pentyl, n-hexyl, dodecyl, etc.

[0043] "Lower alkyl", as in "lower alkyl," "lower alkoxy," "cycloalkyl(lower alkyl)," "aryl(lower alkyl)", or "heteroaryl(lower alkyl)", means a C<sub>1-10</sub> alkyl radical. Preferred lower alkyl radicals are those having from 1 to 6 carbon atoms.

[0044] "Alkenyl" is a linear or branched hydrocarbon radical having from 2 to 20 carbon atoms and at least one carbon-carbon double bond. Examples of alkenyl radicals are: vinyl, 1-propenyl, isobutenyl, etc.

[0045] "Alkynyl" is a linear or branched hydrocarbon radical having from 2 to 20 carbon atoms and at least one carbon-carbon triple bond. Examples of alkynyl radicals are: propargyl, 1-butylnyl, etc.

[0046] "Cycloalkyl" is a monovalent cyclic hydrocarbon radical having from 3 to 12 carbon atoms. Examples of cycloalkyl radicals are: cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, etc.

[0047] "Substituted cycloalkyl" is a monovalent cyclic hydrocarbon radical having from 3 to 12 carbon atoms, which is substituted with one, two, or three substituents each independently selected from aryl, substituted aryl, heteroaryl, halogen, -CF<sub>3</sub>, nitro, -CN, -OR, -SR, -NRR', -C(=O)R, -OC(=O)R, -C(=O)OR, -SO<sub>2</sub>OR, -OSO<sub>2</sub>R, -SO<sub>2</sub>NRR', -NRSO<sub>2</sub>R', -C(=O)NRR', -NRC(=O)R' or -PO<sub>3</sub>HR, where R and R' are, independently, hydrogen, lower alkyl, cycloalkyl, aryl, substituted aryl, aryl(lower alkyl), substituted aryl(lower alkyl), heteroaryl, or heteroaryl(lower alkyl), and having 3 to 12 ring atoms, 1 to 5 of which are heteroatoms chosen, independently, from N, O, or S, and includes monocyclic, condensed heterocyclic, and condensed carbocyclic and heterocyclic rings (eg, piperidyl, 4-morpholyl, 4-piperazinyl, pyrrolidinyl, perhydropyrroliziny, 1,4-diazaperhydroepinyl [perhydro-1,4-diazepinyl], etc.).

[0048] "Cycloalkyl(lower alkyl)" is a lower alkyl radical which is substituted with a cycloalkyl, as previously defined. Examples of cycloalkyl(lower alkyl) radicals are cyclopropylmethyl, cyclobutylethyl, cyclopentylmethyl, cyclohexylmethyl, etc.

[0049] "Heterocycloalkyl" is a monovalent cyclic hydrocarbon radical having 3 to 12 carbon ring atoms, 1 to 5 of which are heteroatoms chosen, independently, from N, O, or S, and includes monocyclic, condensed heterocyclic, and condensed carbocyclic and heterocyclic rings (eg, piperidyl, 4-morpholyl, 4-piperazinyl, pyrrolidinyl, perhydropyrroliziny, 1,4-diazaperhydroepinyl, etc.).

[0050] "Substituted heterocycloalkyl" is a monovalent cyclic hydrocarbon radical having from 3 to 12 carbon atoms, which is substituted with one, two, or three substituents each independently selected from aryl, substituted aryl, heteroaryl, halogen, -CF<sub>3</sub>, nitro, -CN, -OR, -SR, -NRR', -C(=O)R, -OC(=O)R, -C(=O)OR, -SO<sub>2</sub>OR, -OSO<sub>2</sub>R, -SO<sub>2</sub>NRR', -NRSO<sub>2</sub>R', -C(=O)NRR', -NRC(=O)R' or -PO<sub>3</sub>HR, where R and R' are, independently, hydrogen, lower alkyl,

cycloalkyl, aryl, substituted aryl, aryl(lower alkyl), substituted aryl(lower alkyl), heteroaryl, or heteroaryl(lower alkyl), and having 3 to 12 ring atoms, 1 to 5 of which are heteroatoms chosen, independently, from N, O, or S, and includes monocyclic, condensed heterocyclic, and condensed carbocyclic and heterocyclic rings (e.g., piperidyl, 4-morpholyl, 4-piperazinyl, pyrrolidinyl, perhydropyrrolizinyl, 1,4-diazaperhydroepinyl, etc.).

[0051] “Substituted heterocycloalkyl(lower alkyl)” is a lower alkyl radical which is substituted with a monovalent cyclic hydrocarbon radical having from 3 to 12 carbon atoms, which is substituted with one, two, or three substituents each independently selected from aryl, substituted aryl, heteroaryl, halogen,  $-\text{CF}_3$ , nitro,  $-\text{CN}$ ,  $-\text{OR}$ ,  $-\text{SR}$ ,  $-\text{NRR}'$ ,  $-\text{C}(=\text{O})\text{R}$ ,  $-\text{OC}(=\text{O})\text{R}$ ,  $-\text{C}(=\text{O})\text{OR}$ ,  $-\text{SO}_2\text{OR}$ ,  $-\text{OSO}_2\text{R}$ ,  $-\text{SO}_2\text{NRR}'$ ,  $-\text{NRSO}_2\text{R}'$ ,  $-\text{C}(=\text{O})\text{NRR}'$ ,  $-\text{NRC}(=\text{O})\text{R}'$  or  $-\text{PO}_3\text{HR}$ , where R and R' are, independently, hydrogen, lower alkyl, cycloalkyl, aryl, substituted aryl, aryl(lower alkyl), substituted aryl(lower alkyl), heteroaryl, or heteroaryl(lower alkyl), and having 3 to 12 ring atoms, 1 to 5 of which are heteroatoms chosen, independently, from N, O, or S, and includes monocyclic, condensed heterocyclic, and condensed carbocyclic and heterocyclic rings (e.g., piperidyl, 4-morpholyl, 4-piperazinyl, pyrrolidinyl, perhydropyrrolizinyl, 1,4-diazaperhydroepinyl, etc.).

[0052] “Substituted alkyl” or “substituted lower alkyl,” is an alkyl or lower alkyl radical, respectively, which is substituted with one, two, or three substituents each independently selected from aryl, substituted aryl, heteroaryl, halogen,  $-\text{CF}_3$ , nitro,  $-\text{CN}$ ,  $-\text{OR}$ ,  $-\text{SR}$ ,  $-\text{NRR}'$ ,  $-\text{C}(=\text{O})\text{R}$ ,  $-\text{OC}(=\text{O})\text{R}$ ,  $-\text{C}(=\text{O})\text{OR}$ ,  $-\text{SO}_2\text{OR}$ ,  $-\text{OSO}_2\text{R}$ ,  $-\text{SO}_2\text{NRR}'$ ,  $-\text{NRSO}_2\text{R}'$ ,  $-\text{C}(=\text{O})\text{NRR}'$ ,  $-\text{NRC}(=\text{O})\text{R}'$ , or  $-\text{PO}_3\text{HR}$ , where R and R' are, independently, hydrogen, lower alkyl, cycloalkyl, aryl, substituted aryl, aryl(lower alkyl), substituted aryl(lower alkyl), heteroaryl, or heteroaryl(lower alkyl).

[0053] “Halo(lower alkyl)” is a radical derived from lower alkyl containing at least one halogen substituent. Non-limiting examples of halo(lower alkyl) radicals include:  $-\text{CF}_3$ ,  $\text{C}_2\text{F}_5$ , etc..

[0054] “Aryl”, as in “aryl”, “aryloxy”, and “aryl(lower alkyl)”, is a radical derived from an aromatic hydrocarbon containing 6 to 16 ring carbon atoms, having a single ring (e.g., phenyl), or two or more condensed rings, preferably 2 to 3 condensed rings (e.g., naphthyl), or two or more aromatic rings, preferably 2 to 3 aromatic rings, which are linked by a single bond (e.g., biphenyl). Preferred aryl radicals are those containing from 6 to 14 carbon atoms.

[0055] “Substituted aryl” is an aryl radical which is substituted with one, two, or three substituents each independently selected from alkyl, substituted alkyl, halo(lower alkyl), halogen, nitro, -CN, -OR, -SR, -NRR', -C(=O)R, -OC(=O)R, -C(=O)OR, -SO<sub>2</sub>OR, -OSO<sub>2</sub>R, -SO<sub>2</sub>NRR', -PO<sub>3</sub>H<sub>2</sub>, -NRSO<sub>2</sub>R', -C(=O)NRR' or -NRC(=O)R', where R and R' are, independently, hydrogen, lower alkyl, substituted lower alkyl, cycloalkyl, aryl, substituted aryl, optionally substituted aryl(lower alkyl), heteroaryl, or heteroaryl(lower alkyl). Preferred substituted aryl radicals are those substituted with one, two, or three substituents each independently selected from the group consisting of lower alkyl, halogen, -CF<sub>3</sub>, nitro, -CN, -OR, -NRR', -C(=O)NRR', -SO<sub>2</sub>OR, -SO<sub>2</sub>NRR', -PO<sub>3</sub>H<sub>2</sub>, -NRSO<sub>2</sub>R' or -NRC(=O)R'.

[0056] “Heteroaryl”, as in “heteroaryl” and “heteroaryl(lower alkyl)”, is a radical derived from an aromatic hydrocarbon containing 5 to 14 ring atoms, 1 to 5 of which are heteroatoms chosen, independently, from N, O, or S, and includes monocyclic, condensed heterocyclic, and condensed carbocyclic and heterocyclic aromatic rings (e.g., thienyl, furyl, pyrrolyl, pyrimidinyl, isoxazolyl, oxazolyl, indolyl, isobenzofuranyl, purinyl, isoquinolyl, pteridinyl, imidazolyl, pyridyl, pyrazolyl, pyrazinyl, quinolyl, etc.).

[0057] “Substituted heteroaryl” is a heteroaryl radical which is substituted with one, two, or three substituents each independently selected from alkyl, substituted alkyl, halogen, CF<sub>3</sub>, nitro, -CN, -OR, -SR, -NRR', -C(=O)R, OC(=O)R, -C(=O)OR, -SO<sub>2</sub>OR, -OSO<sub>2</sub>R, -SO<sub>2</sub>NRR', -NRSO<sub>2</sub>R', -C(=O)NRR', or -NRC(=O)R', where R and R' are, independently, hydrogen, lower alkyl, substituted lower alkyl, cycloalkyl, aryl, substituted aryl, aryl(lower alkyl), substituted aryl(lower alkyl), heteroaryl, or heteroaryl(lower alkyl). Particularly preferred substituents on the substituted heteroaryl moiety include lower alkyl, substituted lower alkyl, halo(lower alkyl), halogen, nitro, -CN, -OR, -SR, and -NRR'.

[0058] “Aryl(lower alkyl)” is a lower alkyl radical which is substituted with an aryl, as previously defined.

[0059] “Substituted aryl(lower alkyl)” is an aryl(lower alkyl) radical having one to three substituents on either or both of the aryl and the alkyl portion of the radical.

[0060] "Heteroaryl(lower alkyl)" is a lower alkyl radical which is substituted with a heteroaryl, as previously defined.

[0061] "Substituted heteroaryl(lower alkyl)" is a heteroaryl(lower alkyl) radical having one to three substituents on the heteroaryl portion or the alkyl portion of the radical, or both.

[0062] "Lower alkoxy" is an -OR radical, where R is a lower alkyl or cycloalkyl.

[0063] "Halogen" means fluoro, chloro, bromo, or iodo.

[0064] "Stereoisomers" are compounds that have the same sequence of covalent bonds and differ in the relative disposition of their atoms in space.

[0065] "Inner salts" or "Zwitterions" are compounds where the positive and negative groups, such as amine and acid groups within the compound, are equally ionized. The compounds are charge separated species that result from the transfer of a proton from the acidic site to a basic site, typically in a compound containing an amine and an acid group.

[0066] "Tautomers" are isomeric compounds that differ from one another by interchanged positions of  $\sigma$  and  $\pi$  bonds. The compounds are in equilibrium with one another. They may also differ from one another in the position at which a hydrogen atom is attached.

[0067] "Pharmaceutically acceptable excipient" means an excipient that is useful in preparing a pharmaceutical composition that is generally safe, non-toxic, and desirable, and includes excipients that are acceptable for veterinary use as well as for human pharmaceutical use. Such excipients may be solid, liquid, semisolid, or, in the case of an aerosol composition, gaseous.

[0068] "Pharmaceutically acceptable salts and esters" means any salt and ester that is pharmaceutically acceptable and has the desired pharmacological properties. Such salts include salts that may be derived from an inorganic or organic acid, or an inorganic or organic base, including amino acids, which is not toxic or undesirable in any way. Suitable inorganic salts include those formed with the alkali metals, e.g., sodium and potassium, magnesium, calcium, and aluminum. Suitable organic salts include those formed with organic bases such as the amine bases, e.g., ethanolamine, diethanolamine, triethanolamine, tromethamine, *N*-methylglucamine, and the like.

Such salts also include acid addition salts formed with inorganic acids (e.g., hydrochloric and hydrobromic acids) and organic acids (e.g., acetic acid, citric acid, maleic acid, and the alkane and arene-sulfonic acids such as methanesulfonic acid and benzenesulfonic acid). Pharmaceutically acceptable esters include esters formed from carboxy, sulfonyloxy, and phosphonoxy groups present in the compounds, e.g., C<sub>1-6</sub> alkyl esters. When there are two acidic groups present, a pharmaceutically acceptable salt or ester may be a mono-acid-mono-salt or ester or a di-salt or ester; and similarly, where there are more than two acidic groups present, some or all of such groups can be salified or esterified.

[0069] “Therapeutically effective amount” means that amount which, when administered to a mammal for treating a disease, is sufficient to effect such treatment for the disease.

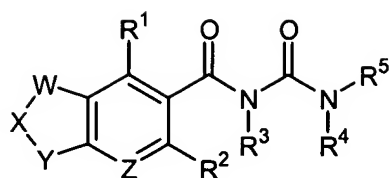
[0070] “Treating” or “treatment” of a disease in a mammal includes:

- (1) Preventing the disease from occurring in a mammal which may be predisposed to the disease but does not yet experience or display symptoms of the disease;
- (2) Inhibiting the disease, *i.e.*, arresting its development, or
- (3) Relieving the disease, *i.e.*, causing regression of the disease.

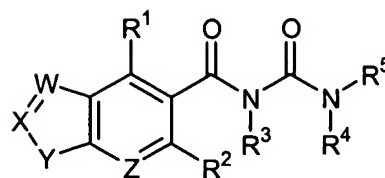
[0071] “Disease” includes any unhealthy condition of an animal (which includes human and non-human mammals), including particularly various forms of inflammatory illnesses or diseases, such as asthma, atherosclerosis, diabetic nephropathy, glomerulonephritis, inflammatory bowel disease, Crohn's disease, multiple sclerosis, pancreatitis, pulmonary fibrosis, psoriasis, restenosis, rheumatoid arthritis, immune disorders, and transplant rejection.

### **The Compounds and Their Pharmaceutically Acceptable Salts**

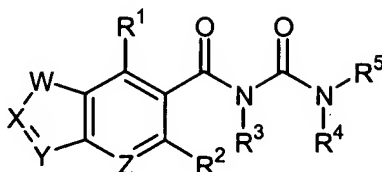
[0072] The first embodiment of the present invention provides compounds of Formula I, Formula II, and Formula III:



I



II



III

where W, X, Y, Z, and R<sup>1</sup> to R<sup>5</sup> are as defined above,  
or a pharmaceutically acceptable salt thereof, optionally in the form of a single stereoisomer or mixture of stereoisomers thereof.

[0073] Preferably, R<sup>1</sup> is hydrogen, optionally substituted lower alkyl, cycloalkyl, optionally substituted heterocycloalkyl, optionally substituted aryl, optionally substituted heteroaryl, optionally substituted aryl(lower alkyl), halogen, -OR<sup>9</sup>, -NR<sup>9</sup>[carboxy(lower alkyl)], -C(=O)OR<sup>9</sup>, -C(=O)NR<sup>9</sup>R<sup>10</sup>, -SO<sub>2</sub>NR<sup>9</sup>R<sup>10</sup>, or -NR<sup>9</sup>C(=O)R<sup>10</sup>, where R<sup>9</sup> and R<sup>10</sup> are independently, hydrogen, optionally substituted lower alkyl, lower alkyl-N(C<sub>1-2</sub> alkyl)<sub>2</sub>, lower alkyl(optionally substituted heterocycloalkyl), optionally substituted cycloalkyl, cycloalkyl(lower alkyl), optionally substituted aryl, optionally substituted heteroaryl, heteroaryl(lower alkyl), or R<sup>9</sup> and R<sup>10</sup> together are -(CH<sub>2</sub>)<sub>4-6</sub>- optionally interrupted by one O, S, NH, N-(aryl), N-(aryl(lower alkyl)), N-(carboxy(lower alkyl)) or N-(optionally substituted C<sub>1-2</sub> alkyl) group.

[0074] More preferably, R<sup>1</sup> is optionally substituted lower alkyl, cycloalkyl, optionally substituted heterocycloalkyl, optionally substituted aryl, optionally substituted heteroaryl, optionally substituted aryl(lower alkyl), halogen, -OR<sup>9</sup>, -NR<sup>9</sup>[carboxy(lower alkyl)], -C(=O)OR<sup>9</sup>, -C(=O)NR<sup>9</sup>R<sup>10</sup>, -SO<sub>2</sub>NR<sup>9</sup>R<sup>10</sup>, or -NR<sup>9</sup>C(=O)R<sup>10</sup>, where R<sup>9</sup> and R<sup>10</sup> are independently, hydrogen, optionally substituted lower alkyl, lower alkyl-N(C<sub>1-2</sub> alkyl)<sub>2</sub>, lower alkyl(optionally substituted heterocycloalkyl), optionally substituted cycloalkyl, cycloalkyl(lower alkyl), optionally substituted aryl, optionally

substituted heteroaryl, heteroaryl(lower alkyl), or  $R^9$  and  $R^{10}$  together are  $-(CH_2)_{4-6}-$  optionally interrupted by one O, S, NH, N-(aryl), N-(aryl(lower alkyl)), N-(carboxy(lower alkyl)) or N-(optionally substituted  $C_{1-2}$  alkyl) group.

[0075] Preferably,  $R^2$  is hydrogen, optionally substituted lower alkyl, optionally substituted heterocycloalkyl, optionally substituted aryl, optionally substituted heteroaryl, optionally substituted aryl(lower alkyl), halo(lower alkyl), halogen,  $-OR^9$ ,  $-NR^9R^{10}$ ,  $-C(=O)OR^9$ , or  $-C(=O)NR^9R^{10}$ , where  $R^9$  and  $R^{10}$  are independently, hydrogen, optionally substituted lower alkyl, lower alkyl-N( $C_{1-2}$  alkyl)<sub>2</sub>, lower alkyl(optionally substituted heterocycloalkyl), optionally substituted cycloalkyl, cycloalkyl(lower alkyl), optionally substituted aryl, optionally substituted heteroaryl, heteroaryl(lower alkyl), or  $R^9$  and  $R^{10}$  together are  $-(CH_2)_{4-6}-$  optionally interrupted by one O, S, NH, N-(aryl), N-[aryl(lower alkyl)], N-(carboxy(lower alkyl)) or N-(optionally substituted  $C_{1-2}$  alkyl) group.

[0076] More preferably,  $R^2$  is optionally substituted lower alkyl, optionally substituted heterocycloalkyl, optionally substituted aryl, optionally substituted heteroaryl, optionally substituted aryl(lower alkyl), halo(lower alkyl), halogen,  $-OR^9$ ,  $-NR^9R^{10}$ ,  $-C(=O)OR^9$ , or  $-C(=O)NR^9R^{10}$ , where  $R^9$  and  $R^{10}$  are independently, hydrogen, optionally substituted lower alkyl, lower alkyl-N( $C_{1-2}$  alkyl)<sub>2</sub>, lower alkyl(optionally substituted heterocycloalkyl), optionally substituted cycloalkyl, cycloalkyl(lower alkyl), optionally substituted aryl, heteroaryl, heteroaryl(lower alkyl), or  $R^9$  and  $R^{10}$  together are  $-(CH_2)_{4-6}-$  optionally interrupted by one O, S, NH, N-(aryl), N-[aryl(lower alkyl)], N-[carboxy(lower alkyl)] or N-(optionally substituted  $C_{1-2}$  alkyl) group.

[0077] Preferably,  $R^3$  and  $R^4$  are independently, hydrogen or lower alkyl, or together are  $-(CH_2)_{2-4}-$ . More preferably,  $R^3$  and  $R^4$  are independently, hydrogen or lower alkyl.

[0078] Preferably,  $R^5$  is hydrogen, optionally substituted lower alkyl, alkenyl, alkynyl, cycloalkyl, cycloalkyl(lower alkyl), optionally substituted heterocycloalkyl, optionally substituted aryl, aryl(lower alkyl), optionally substituted heteroaryl, optionally substituted heteroaryl(lower alkyl), halo(lower alkyl),  $-C(=O)R^{11}$ ,  $-C(=O)OR^{11}$ ,  $-C(=O)NR^{11}R^{12}$ ,  $-SO_2R^{11}$ , or  $-SO_2NR^{11}R^{12}$ , where  $R^{11}$  and  $R^{12}$  are independently, hydrogen, optionally substituted lower alkyl, alkenyl, alkynyl, cycloalkyl, cycloalkyl(lower alkyl), aryl, heteroaryl, heteroaryl(lower alkyl), or  $R^{11}$  and  $R^{12}$  together are  $-(CH_2)_{4-6}-$ .



[0079] Preferably,  $R^6$  and  $R^7$  are independently hydrogen, optionally substituted lower alkyl, alkenyl, cycloalkyl, cycloalkyl(lower alkyl), optionally substituted heterocycloalkyl, optionally substituted aryl, optionally substituted aryl(lower alkyl), optionally substituted heteroaryl, optionally substituted heteroaryl(lower alkyl),  $-C(=O)R^9$ ,  $-C(=O)OR^9$ ,  $-C(=O)NR^9R^{10}$ ,  $-SO_2R^9$ , or  $-SO_2NR^9R^{10}$ , where  $R^9$  and  $R^{10}$  are independently, hydrogen, optionally substituted lower alkyl, cycloalkyl, cycloalkyl(lower alkyl), aryl, heteroaryl, heteroaryl(lower alkyl), or  $R^9$  and  $R^{10}$  together are  $-(CH_2)_{4-6}$ .

[0080] More preferably,  $R^6$  and  $R^7$  are independently hydrogen, optionally substituted lower alkyl, optionally substituted heterocycloalkyl, optionally substituted aryl, optionally substituted heteroaryl, optionally substituted aryl(lower alkyl),  $-C(=O)R^9$ ,  $-C(=O)OR^9$ ,  $-C(=O)NR^9R^{10}$ ,  $-SO_2R^9$ , or  $-SO_2NR^9R^{10}$ , where  $R^9$  and  $R^{10}$  are independently, hydrogen, optionally substituted lower alkyl, lower alkyl- $N(C_{1-2} \text{ alkyl})_2$ , alkenyl, alkynyl, optionally substituted cycloalkyl, cycloalkyl(lower alkyl), optionally substituted aryl, heteroaryl, or heteroaryl(lower alkyl).

[0081] Preferably,  $R^8$  is hydrogen, optionally substituted lower alkyl, optionally substituted heterocycloalkyl, optionally substituted aryl, optionally substituted heteroaryl, optionally substituted aryl(lower alkyl), halo(lower alkyl),  $-CF_3$ , halogen,  $-OR^9$ ,  $-NR^9R^{10}$ ,  $-C(=O)R^9$ ,  $-C(=O)OR^9$ ,  $-C(=O)NR^9R^{10}$ ,  $-OC(=O)R^9$ ,  $-SO_2R^9$ ,  $-SO_2NR^9R^{10}$ ,  $-NR^9SO_2R^{10}$  or  $-NR^9C(=O)R^{10}$ , where  $R^9$  and  $R^{10}$  are independently, hydrogen, optionally substituted lower alkyl, lower alkyl- $N(C_{1-2} \text{ alkyl})_2$ , optionally substituted cycloalkyl, cycloalkyl(lower alkyl), optionally substituted aryl, heteroaryl, heteroaryl(lower alkyl), or  $R^9$  and  $R^{10}$  together are  $-(CH_2)_{4-6}$  optionally interrupted by one O, S, NH, N-(aryl), N-(aryl(lower alkyl)), N-(carboxy(lower alkyl)) or N-(optionally substituted  $C_{1-2}$  alkyl) group.

[0082] Where  $R^9$  and  $R^{10}$  together are  $-(CH_2)_{4-6}$  optionally interrupted by one O, S, NH, N-(aryl), N-[aryl(lower alkyl)], N-[carboxy(lower alkyl)] or N-(optionally substituted  $C_{1-2}$  alkyl) group, examples include piperidiny, piperaziny, 4-methylpiperaziny, 4-(carboxymethyl)piperaziny, 4-morpholy, and hexahydropyrimidyl.

[0083] A particularly preferred "substituted aryl" is a phenyl group substituted with  $R^{13}$  and optionally substituted with up to four  $R^{14}$ s, where  $R^{13}$  and  $R^{14}$  are defined with respect to Formulae Ia, IIa and IIIa.

[0084] The above-listed preferences equally apply for the compounds of Formulae Ia, IIa, and IIIa below.

[0085] In a more preferred version of the first embodiment of the invention,  
(A) in Formula I;

W and X are C-R<sup>6</sup>, Y is O, and Z is C-R<sup>8</sup>, or  
W and Y are O, and Z is C-R<sup>8</sup>.

[0086] In another more preferred version of the first embodiment of the invention,  
(B) in Formula II;

W is N, Y is O, and Z is C-R<sup>8</sup>, or  
W and X are C-R<sup>6</sup>, Y is N-R<sup>7</sup>, and Z is C-R<sup>8</sup>, or  
W and X are N, Y is N-R<sup>7</sup>, and Z is C-R<sup>8</sup>, or  
W is N and Y is N-R<sup>7</sup>, and Z is C-R<sup>8</sup>.

[0087] In another more preferred version of the first embodiment of the invention,  
(C) in Formula III;

W is N-R<sup>7</sup>, and Z is C-R<sup>8</sup>, or  
W is O and Y is N, and Z is C-R<sup>8</sup>. or  
W is N-R<sup>7</sup>, and X and Y are C-R<sup>6</sup>, and Z is C-R<sup>8</sup>.

For (A), (B) and (C);

R<sup>1</sup>, R<sup>3</sup> and R<sup>4</sup> are hydrogen, and

R<sup>5</sup> is optionally substituted aryl or optionally substituted heteroaryl.

or a pharmaceutically acceptable salt thereof, optionally in the form of a single stereoisomer or mixture of stereoisomers thereof.

[0088] In another more preferred version of the first embodiment of the invention,

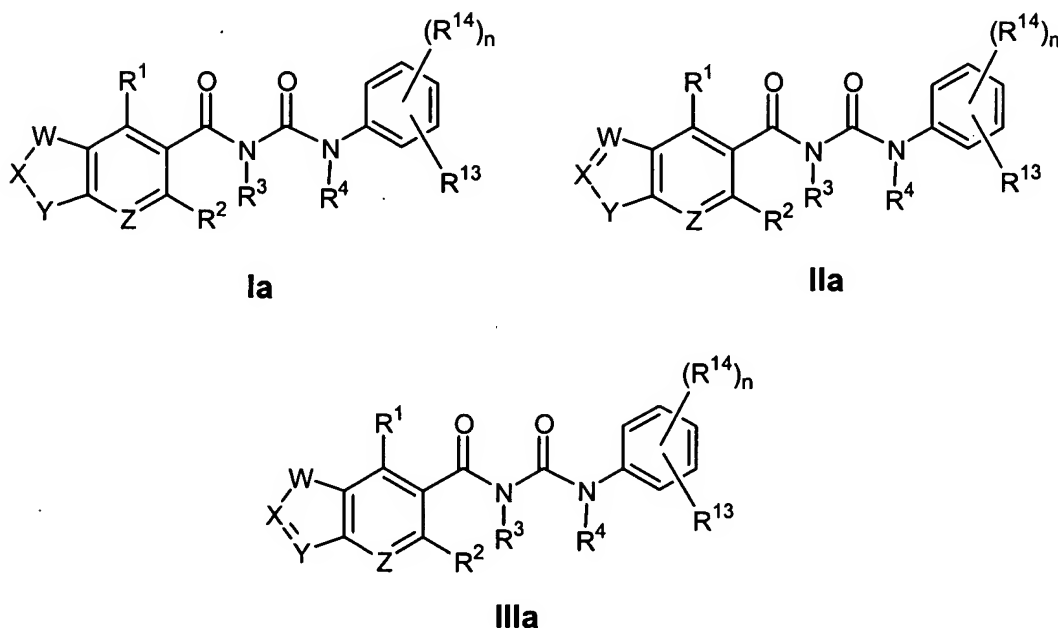
R<sup>2</sup> is hydrogen or chlorine,

R<sup>3</sup> and R<sup>4</sup> are hydrogen or lower alkyl, and

R<sup>5</sup> is optionally substituted aryl or optionally substituted heteroaryl,

or a pharmaceutically acceptable salt thereof, optionally in the form of a single stereoisomer or mixture of stereoisomers thereof.

[0089] The second embodiment of the present invention provides compounds of Formula Ia, Formula IIa, or Formula IIIa:



where:

(A) in Formula Ia:

each of W, X and Y is independently selected from CR<sup>6</sup>R<sup>7</sup>, N-R<sup>7</sup>, O, or S provided that at least one of W, X, and Y is a non-carbon ring atom, and at least one of W, X, and Y is a carbon ring atom;

(B) in Formula IIa:

W and X are independently selected from C-R<sup>6</sup> and N, and Y is selected from CR<sup>6</sup>R<sup>7</sup>, N-R<sup>7</sup>, O, or S, provided that:

- (i) at least one of W, X, and Y is a non-carbon ring atom, and
- (ii) when W is C-R<sup>6</sup> and X is N, then Y is CR<sup>6</sup>R<sup>7</sup>;

(C) in Formula IIIa:

W is selected from CR<sup>6</sup>R<sup>7</sup>, N-R<sup>7</sup>, O, or S, and X and Y are independently selected from C-R<sup>6</sup> and N, provided that:

- (i) at least one of W, X, and Y is a non-carbon ring atom, and
- (ii) when X is N and Y is C-R<sup>6</sup>, then W is CR<sup>6</sup>R<sup>7</sup>;

and where:

Z is N or C-R<sup>8</sup>;

R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup>, R<sup>6</sup>, R<sup>7</sup>, and R<sup>8</sup> are as defined in the first embodiment,

[0090] R<sup>13</sup> is hydrogen, optionally substituted lower alkyl, alkenyl, alkynyl, cycloalkyl, cycloalkyl(lower alkyl), heterocycloalkyl, optionally substituted aryl, optionally substituted aryl(lower alkyl), optionally substituted heteroaryl, optionally substituted heteroaryl(lower alkyl), halo(lower alkyl), -CF<sub>3</sub>, halogen, nitro, -CN, -OR<sup>15</sup>, -SR<sup>15</sup>, -NR<sup>15</sup>R<sup>16</sup>, -C(=O)R<sup>15</sup>, -C(=O)OR<sup>15</sup>, -C(=O)NR<sup>15</sup>R<sup>16</sup>, -OC(=O)R<sup>15</sup>, -SO<sub>2</sub>R<sup>15</sup>, -SO<sub>2</sub>NR<sup>15</sup>R<sup>16</sup>, -NR<sup>15</sup>SO<sub>2</sub>R<sup>16</sup> or -NR<sup>15</sup>C(=O)R<sup>16</sup>, where R<sup>15</sup> and R<sup>16</sup> are independently, hydrogen, optionally substituted lower alkyl, alkenyl, alkynyl, -CF<sub>3</sub>, cycloalkyl, halo(lower alkyl), optionally substituted heterocycloalkyl, cycloalkyl(lower alkyl), optionally substituted aryl, optionally substituted heteroaryl, optionally substituted heteroaryl(lower alkyl) or, together, are -(CH<sub>2</sub>)<sub>4-6</sub>- optionally interrupted by one O, S, NH or N-(C<sub>1-2</sub> alkyl) group,

each R<sup>14</sup> is independently selected from optionally substituted lower alkyl, optionally substituted aryl, optionally substituted heteroaryl, hydroxy, halogen, -CF<sub>3</sub>, -OR<sup>17</sup>, -NR<sup>17</sup>R<sup>18</sup>, -C(=O)R<sup>17</sup>, -C(=O)OR<sup>17</sup>, -O(CH<sub>2</sub>)<sub>m</sub>C(=O)OR<sup>17</sup>, where m is an integer of 1 to 4, or -C(=O)NR<sup>17</sup>R<sup>18</sup>, where R<sup>17</sup> and R<sup>18</sup> are independently, hydrogen, lower alkyl, alkenyl, alkynyl, -CF<sub>3</sub>, optionally substituted heterocycloalkyl, cycloalkyl, cycloalkyl(lower alkyl), optionally substituted aryl, heteroaryl, heteroaryl(lower alkyl) or, together, are -(CH<sub>2</sub>)<sub>4-6</sub>-, optionally interrupted by one O, S, NH or N-(C<sub>1-2</sub> alkyl) group, and

n is an integer of 0 to 4,

and the pharmaceutically acceptable salts thereof, optionally in the form of single stereoisomers or mixtures of stereoisomers thereof.

[0091] Preferably, R<sup>1</sup>, R<sup>2</sup>, and R<sup>8</sup> are optionally substituted lower alkyl, cycloalkyl, optionally substituted heterocycloalkyl, optionally substituted aryl, optionally substituted heteroaryl, optionally substituted aryl(lower alkyl), halogen, -OR<sup>9</sup>, -NR<sup>9</sup>[carboxy(lower alkyl)], -C(=O)OR<sup>9</sup>, -C(=O)NR<sup>9</sup>R<sup>10</sup>, -SO<sub>2</sub>NR<sup>9</sup>R<sup>10</sup>, or -NR<sup>9</sup>C(=O)R<sup>10</sup>, where R<sup>9</sup> and R<sup>10</sup> are independently, hydrogen, lower alkyl, or R<sup>9</sup> and R<sup>10</sup> together are -(CH<sub>2</sub>)<sub>4-6</sub>- optionally interrupted by one O, S, NH, N-(aryl), N-(aryl(lower alkyl)), N-(carboxy(lower alkyl)) or N-(optionally substituted C<sub>1-2</sub> alkyl) group,

n is a stereocompatible integer of 0 to 4. The term "stereocompatible" limits the number of substituents permissible by available valences in accordance with space requirements of the substituents.

[0092] Preferably,  $R^{13}$  is hydrogen, optionally substituted lower alkyl, alkenyl, heterocycloalkyl, optionally substituted aryl, optionally substituted aryl(lower alkyl), optionally substituted heteroaryl, optionally substituted heteroaryl(lower alkyl), halo(lower alkyl),  $-CF_3$ , halogen, nitro,  $-CN$ ,  $-OR^{15}$ ,  $-SR^{15}$ ,  $-NR^{15}R^{16}$ ,  $-C(=O)R^{15}$ ,  $-C(=O)OR^{15}$ ,  $-C(=O)NR^{15}R^{16}$ ,  $-OC(=O)R^{15}$ ,  $-SO_2R^{15}$ ,  $-SO_2NR^{15}R^{16}$ , or  $-NR^{15}C(=O)R^{16}$ , where  $R^{15}$  and  $R^{16}$  are independently, hydrogen, optionally substituted lower alkyl, alkenyl, cycloalkyl, optionally substituted heterocycloalkyl, cycloalkyl(lower alkyl), optionally substituted aryl, optionally substituted heteroaryl, optionally substituted heteroaryl(lower alkyl) or, together, are  $-(CH_2)_{4-6}$  optionally interrupted by one O, S, NH or N-( $C_{1-2}$  alkyl) group.

[0093] More preferably,  $R^{13}$  is optionally substituted lower alkyl, alkenyl, heterocycloalkyl, optionally substituted aryl, optionally substituted aryl(lower alkyl), optionally substituted heteroaryl, optionally substituted heteroaryl(lower alkyl), halo(lower alkyl),  $-CF_3$ , halogen, nitro,  $-CN$ ,  $-OR^{15}$ ,  $-SR^{15}$ ,  $-NR^{15}R^{16}$ ,  $-C(=O)R^{15}$ ,  $-C(=O)OR^{15}$ ,  $-C(=O)NR^{15}R^{16}$ ,  $-OC(=O)R^{15}$ ,  $-SO_2R^{15}$ ,  $-SO_2NR^{15}R^{16}$ , or  $-NR^{15}C(=O)R^{16}$ , where  $R^{15}$  and  $R^{16}$  are independently, hydrogen, optionally substituted lower alkyl, alkenyl, cycloalkyl, optionally substituted heterocycloalkyl, cycloalkyl(lower alkyl), optionally substituted aryl, optionally substituted heteroaryl, optionally substituted heteroaryl(lower alkyl) or, together, are  $-(CH_2)_{4-6}$  optionally interrupted by one O, S, NH or N-( $C_{1-2}$  alkyl) group.

[0094] Preferably, each  $R^{14}$  is independently selected from optionally substituted lower alkyl, optionally substituted aryl, optionally substituted heteroaryl, hydroxy, halogen,  $-CF_3$ ,  $-OR^{17}$ ,  $-NR^{17}R^{18}$ ,  $-C(=O)R^{18}$ ,  $-C(=O)OR^{18}$ ,  $-C(=O)NR^{17}R^{18}$ , where  $R^{17}$  and  $R^{18}$  are, independently, hydrogen, lower alkyl, alkenyl, or optionally substituted aryl.

[0095] Preferably, where  $R^{13}$  is not hydrogen, n is an integer of 1 to 2. More preferably, where  $R^{13}$  is not hydrogen, n is 1.

[0096] In a more preferred version of the second embodiment of the invention, (A) in Formula Ia;

W and X are C-R<sup>6</sup>, Y is O, and Z is C-R<sup>8</sup>, or

W and Y are O, and Z is C-R<sup>8</sup>,

each R<sup>13</sup> and R<sup>14</sup> is, independently, lower alkyl, alkynyl, optionally substituted aryl, optionally substituted heteroaryl, halo(lower alkyl), -CF<sub>3</sub>, halogen, nitro, -OR<sup>15</sup>, -SR<sup>15</sup>, or -C(=O)NR<sup>15</sup>R<sup>16</sup>, where R<sup>15</sup> and R<sup>16</sup> are independently, hydrogen, optionally substituted lower alkyl, or -CF<sub>3</sub>, or

W and X are CR<sup>6</sup>R<sup>7</sup>, Y is O, and each R<sup>13</sup> and R<sup>14</sup> is, independently, -CF<sub>3</sub>, halogen, -OR<sup>15</sup>, where R<sup>15</sup> is independently, hydrogen, optionally substituted lower alkyl, or -CF<sub>3</sub>.

[0097] In another more preferred version of the second embodiment of the invention, (B) in Formula IIa;

W is N, Y is O, and Z is C-R<sup>8</sup>, and each R<sup>13</sup> and R<sup>14</sup> is, independently, -CF<sub>3</sub>, halogen, or

W and X are C-R<sup>6</sup>, Y is N-R<sup>7</sup>, Z is C-R<sup>8</sup>, and each R<sup>13</sup> and R<sup>14</sup> is, independently, -CF<sub>3</sub>, or halogen, or

W and X are N, Y is N-R<sup>7</sup>, Z is C-R<sup>8</sup>, and R<sup>13</sup> and R<sup>14</sup> are halogen, or

W is N and Y is N-R<sup>7</sup>, Z is C-R<sup>8</sup>, and R<sup>13</sup> and R<sup>14</sup> are halogen.

[0098] In another more preferred version of the second embodiment of the invention, (C) in Formula IIIa;

W is N-R<sup>7</sup>, Z is C-R<sup>8</sup>, and each R<sup>13</sup> and R<sup>14</sup> is, independently, -CF<sub>3</sub>, halogen, or -CN, or

W is O and Y is N, Z is C-R<sup>8</sup>, and each R<sup>13</sup> and R<sup>14</sup> is, independently, halo(lower alkyl), -CF<sub>3</sub>, halogen, nitro, -OR<sup>15</sup>, -SR<sup>15</sup>, or -CO<sub>2</sub>R<sup>15</sup>, where R<sup>15</sup> is hydrogen, or -CF<sub>3</sub>, or

W is N-R<sup>7</sup>, and X and Y are C-R<sup>6</sup>, Z is C-R<sup>8</sup>, and each R<sup>13</sup> and R<sup>14</sup> is, independently, -CF<sub>3</sub>, halogen, or -CN.

[0099] Most preferably, independently,

1. For Formula Ia, W and Y is O, X is CR<sup>6</sup>R<sup>7</sup>, and Z is C-H.
2. For Formula IIa, W is N, X is C-H, Y is O, and Z is C-H.
3. For Formula IIa, W and X are C-H, Y is N-CH<sub>3</sub>, and Z is C-H.
4. For Formula IIa, W and X are N, Y is N-H, and Z is C-H.
5. For Formula IIIa, W is O, X is C-H, Y is N, and Z is C-H.
6. For Formula IIIa, W is N-CH<sub>3</sub>, X is C-H, Y is N-CH<sub>3</sub>, and Z is C-H.
7. R<sup>1</sup>, R<sup>3</sup> and R<sup>4</sup> are hydrogen.

8.  $R^2$  is hydrogen or chlorine.
9.  $R^{13}$  and  $R^{14}$  are independently selected from lower alkyl, halogen, optionally substituted aryl, optionally substituted heteroaryl,  $-CF_3$ , nitro,  $-OCF_3$ ,  $-SCF_3$ , halo(lower alkyl),  $-CN$ ,  $-OR^{15}$ ,  $-C(=O)R^{15}$ ,  $-C(=O)OR^{15}$ ,  $-C(=O)NR^{15}R^{16}$ , or  $-CO_2H$ .

[0100] The preferred compounds of the invention are listed in Tables 1-11 below.

[0101] The compounds of this invention may possess one or more chiral centers, and can therefore exist as individual stereoisomers or as mixtures of stereoisomers. In such cases, all stereoisomers also fall within the scope of this invention. The compounds of this invention may also exist in various tautomeric forms, and in such cases, all tautomers also fall within the scope of this invention. The invention compounds include the individually isolated stereoisomers and tautomers as well as mixtures of such stereoisomers and their tautomers.

[0102] Some of the compounds of Formula I, Formula II, and Formula III are capable of further forming pharmaceutically acceptable salts and esters. All of these forms are included within the scope of the present invention.

[0103] Pharmaceutically acceptable base addition salts of the compounds of Formula I, Formula II, and Formula III include salts which may be formed when acidic protons present in the parent compound are capable of reacting with inorganic or organic bases. Typically, the parent compound is treated with an excess of an alkaline reagent, such as hydroxide, carbonate, or alkoxide, containing an appropriate cation. Cations such as  $Na^+$ ,  $K^+$ ,  $Ca^{2+}$ , and  $NH_4^+$  are examples of cations present in pharmaceutically acceptable salts. The  $Na^+$  salts are especially useful. Acceptable inorganic bases, therefore, include aluminum hydroxide, calcium hydroxide, potassium hydroxide, sodium carbonate and sodium hydroxide. Salts may also be prepared using organic bases, such as choline, dicyclohexylamine, ethylenediamine, ethanolamine, diethanolamine, triethanolamine, procaine, *N*-methylglucamine, and the like [for a nonexclusive list see, for example, Berge et al., "Pharmaceutical Salts," *J. Pharma. Sci.* 66:1 (1977)]. The free acid form may be regenerated by contacting the base addition salt with an acid and isolating the free acid in the conventional manner. The free acid forms can differ from their respective salt forms somewhat in certain physical properties such as solubility in polar solvents.

[0104] Pharmaceutically acceptable acid addition salts of the compounds of Formula I, Formula II, and Formula III include salts which may be formed when the parent compound contains a basic group. Acid addition salts of the compounds are prepared in a suitable solvent from the parent compound and an excess of a non-toxic inorganic acid, such as hydrochloric acid, hydrobromic acid, sulfuric acid (giving the sulfate and bisulfate salts), nitric acid, phosphoric acid and the like, or a non-toxic organic acid such as acetic acid, propionic acid, glycolic acid, pyruvic acid, oxalic acid, malic acid, malonic acid, succinic acid, maleic acid, fumaric acid, tartaric acid, citric acid, benzoic acid, cinnamic acid, mandelic acid, methanesulfonic acid, ethanesulfonic acid, salicylic acid, *p*-toluenesulfonic acid, hexanoic acid, heptanoic acid, cyclopentanepropionic acid, lactic acid,  $\alpha$ -(4-hydroxy-benzoyl)benzoic acid, 1,2-ethanedisulfonic acid, 2-hydroxyethanesulfonic acid, benzenesulfonic acid, *p*-chlorobenzenesulfonic acid, 2-naphthalenesulfonic acid, camphorsulfonic acid, 4-methyl-bicyclo[2.2.2.]oct-2-ene-1-carboxylic acid, glucoheptonic acid, gluconic acid, 4,4'-methylenebis(3-hydroxy-2-naphthoic)acid, 3-phenylpropionic acid, trimethylacetic acid, *tert*-butylacetic acid, laurylsulfuric acid, glucuronic acid, glutamic acid, 3-hydroxy-2-naphthoic acid, stearic acid, muconic acid, and the like. The free base form may be regenerated by contacting the acid addition salt with a base and isolating the free base in the conventional manner. The free base forms can differ from their respective salt forms somewhat in certain physical properties such as solubility in polar solvents.

[0105] Also included in the embodiment of the present invention are salts of amino acids such as arginate and the like, gluconate, and galacturonate [see Berge, *supra* (1977)].

[0106] Some of the compounds of the invention may form inner salts or Zwitterions.

[0107] Certain of the compounds of the present invention can exist in unsolvated forms as well as solvated forms, including hydrated forms, and are intended to be encompassed within the scope of the present invention.

[0108] Certain of the compounds of the present invention may also exist in one or more solid or crystalline phases or polymorphs, the variable biological activities of such polymorphs or mixtures of such polymorphs are also included in the scope of this invention.



## Pharmaceutical Compositions

[0109] A third embodiment of the present invention provides pharmaceutical compositions comprising pharmaceutically acceptable excipients and a therapeutically effective amount of at least one compound of this invention.

[0110] Pharmaceutical compositions of the compounds of this invention, or derivatives thereof, may be formulated as solutions or lyophilized powders for parenteral administration. Powders may be reconstituted by addition of a suitable diluent or other pharmaceutically acceptable carrier prior to use. The liquid formulation is generally a buffered, isotonic, aqueous solution. Examples of suitable diluents are normal isotonic saline solution, 5% dextrose in water or buffered sodium or ammonium acetate solution. Such formulations are especially suitable for parenteral administration but may also be used for oral administration. It may be desirable to add excipients such as polyvinylpyrrolidinone, gelatin, hydroxycellulose, acacia, polyethylene glycol, mannitol, sodium chloride, or sodium citrate.

[0111] Alternatively, these compounds may be encapsulated, tableted, or prepared in an emulsion or syrup for oral administration. Pharmaceutically acceptable solid or liquid carriers may be added to enhance or stabilize the composition, or to facilitate preparation of the composition. Liquid carriers include syrup, peanut oil, olive oil, glycerin, saline, alcohols, or water. Solid carriers include starch, lactose, calcium sulfate, dihydrate, terra alba, magnesium stearate or stearic acid, talc, pectin, acacia, agar, or gelatin. The carrier may also include a sustained release material such as glyceryl monostearate or glyceryl distearate, alone or with a wax. The amount of solid carrier varies but, preferably, will be between about 20 mg to about 1 g per dosage unit.

[0112] The pharmaceutical preparations are made following the conventional techniques of pharmacy involving milling, mixing, granulation, and compressing, when necessary, for tablet forms; or milling, mixing, and filling for hard gelatin capsule forms. When a liquid carrier is used, the preparation will be in the form of a syrup, elixir, emulsion, or an aqueous or non-aqueous suspension. Such a liquid formulation may be administered directly p.o. or filled into a soft gelatin capsule.

[0113] Some specific examples of suitable pharmaceutical compositions are described in Examples 7-9.

[0114] Typically, a pharmaceutical composition of the present invention is packaged in a container with a label indicating the use of the pharmaceutical composition in the treatment of a disease such as asthma, atherosclerosis, diabetic nephropathy, glomerulonephritis, inflammatory bowel disease, Crohn's disease, multiple sclerosis, pancreatitis, pulmonary fibrosis, psoriasis, restenosis, rheumatoid arthritis, and transplant rejection, or a chronic or acute immune disorder, or a combination of any of these disease conditions.

#### Methods of Use

[0115] A fourth embodiment of the present invention provides a method for treating a disease treatable by administration of an MCP-1 inhibitor, for example, chronic or acute inflammatory disease such as asthma, atherosclerosis, diabetic nephropathy, glomerulonephritis, inflammatory bowel disease, Crohn's disease, multiple sclerosis, pancreatitis, pulmonary fibrosis, psoriasis, restenosis, rheumatoid arthritis, or a chronic or acute immune disorder, or a transplant rejection in mammals in need thereof, comprising the administration to such mammal of a therapeutically effective amount of at least one compound of Formula I, Formula Ia, Formula II, Formula IIa, Formula III, Formula IIIa, or a pharmaceutically acceptable salt or ester thereof.

[0116] The compounds of the present invention inhibit chemotaxis of a human monocytic cell line (THP-1 cells) induced by human MCP-1 *in vitro*. This inhibitory effect has also been observed *in vivo*. The compounds have been shown to reduce monocyte infiltration in a thioglycollate-induced inflammation model in mice.

[0117] The compounds of the present invention have been found to prevent the onset or ameliorate symptoms in several animal models of inflammation. For example, the compounds inhibited the infiltration of ED-1 positive cells into the glomeruli and reduced the amount of urinary protein excretion in an anti-Thy-1 antibody-induced model of nephritis.

[0118] The ability of the compounds of this invention to block the migration of monocytes and prevent or ameliorate inflammation, which is demonstrated in the specific examples, indicates

their usefulness in the treatment and management of disease states associated with aberrant leukocyte recruitment.

[0119] The use of the compounds of the invention for treating inflammatory and autoimmune disease by combination therapy may also comprise the administration of the compound of the invention to a mammal in combination with common anti-inflammatory drugs, cytokines, or immunomodulators.

[0120] The compounds of this invention are thus used to inhibit leukocyte migration in patients which require such treatment. The method of treatment comprises the administration, orally or parenterally, of an effective quantity of the chosen compound of the invention, preferably dispersed in a pharmaceutical carrier. Dosage units of the active ingredient are generally selected from the range of 0.01 to 1000 mg/kg, preferably 0.01 to 100 mg/kg, and more preferably 0.1 to 50 mg/kg, but the range will be readily determined by one skilled in the art depending on the route of administration, age, and condition of the patient. These dosage units may be administered one to ten times daily for acute or chronic disease. No unacceptable toxicological effects are expected when compounds of the invention are used in accordance with the present invention.

[0121] The invention compounds may be administered by any route suitable to the subject being treated and the nature of the subject's condition. Routes of administration include, but are not limited to, administration by injection, including intravenous, intraperitoneal, intramuscular, and subcutaneous injection, by transmucosal or transdermal delivery, through topical applications, nasal spray, suppository and the like, or may be administered orally. Formulations may optionally be liposomal formulations, emulsions, formulations designed to administer the drug across mucosal membranes or transdermal formulations. Suitable formulations for each of these methods of administration may be found in, for example, "Remington: The Science and Practice of Pharmacy", A. Gennaro, ed., 20th edition, Lippincott, Williams & Wilkins, Philadelphia, PA.

### Examples

[0122] The following Examples serve to illustrate the preparation, properties, and therapeutic applications of the compounds of this invention. These Examples are not intended to

limit the scope of this invention, but rather to show how to prepare and use the compounds of this invention.

#### Preparation of the Compounds of the Invention: General Procedures

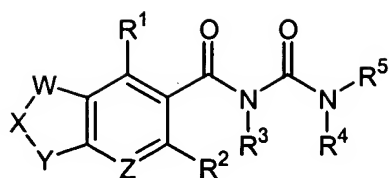
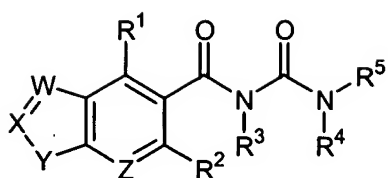
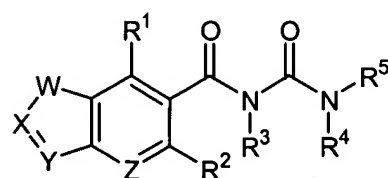
[0123] The following general procedures may be employed for the preparation of the compounds of the present invention.

[0124] The starting materials and reagents used in preparing these compounds are either available from commercial suppliers such as the Aldrich Chemical Company (Milwaukee, WI), Bachem (Torrance, CA), Sigma (St. Louis, MO), or are prepared by methods well known to a person of ordinary skill in the art, following procedures described in such references as Fieser and Fieser's *Reagents for Organic Synthesis*, vols. 1-17, John Wiley and Sons, New York, NY, 1991; *Rodd's Chemistry of Carbon Compounds*, vols. 1-5 and supps., Elsevier Science Publishers, 1989; *Organic Reactions*, vols. 1-40, John Wiley and Sons, New York, NY, 1991; March J.: *Advanced Organic Chemistry*, 4th ed., John Wiley and Sons, New York, NY; and Larock: *Comprehensive Organic Transformations*, VCH Publishers, New York, 1989.

[0125] In some cases, protective groups may be introduced and finally removed. For example, suitable protective groups for amino, hydroxy, and carboxy groups are described in Greene et al., *Protective Groups in Organic Synthesis*, Second Edition, John Wiley and Sons, New York, 1991. Activation of carboxylic acids can be achieved by using a number of different reagents as described in Larock: *Comprehensive Organic Transformations*, VCH Publishers, New York, 1989.

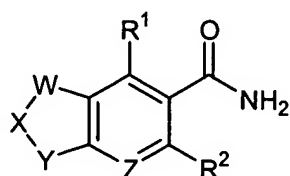
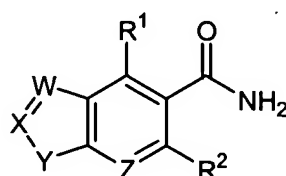
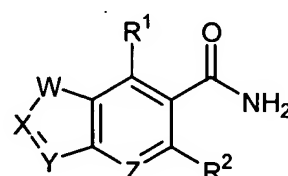
[0126] The starting materials, intermediates, and compounds of this invention may be isolated and purified using conventional techniques, including precipitation, filtration, distillation, crystallization, chromatography, and the like. The compounds may be characterized using conventional methods, including physical constants and spectroscopic methods.

[0127] Generally, a compound of Formula I, Formula II, or Formula III:

**I****II****III**

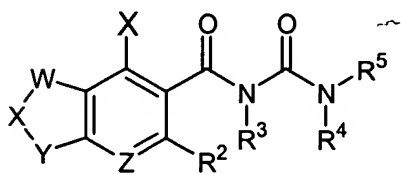
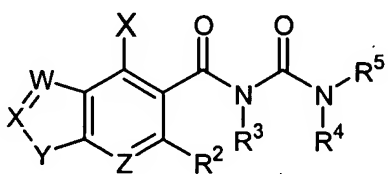
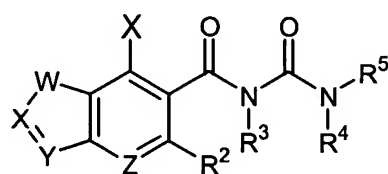
where n, W, X, Y, Z, and R<sup>1</sup> - R<sup>5</sup> are as defined in the first embodiment, may be prepared by a process comprising:

- (a) contacting a compound of Formula Ib, Formula IIb, or Formula IIIb:

**Ib****IIb****IIIb**

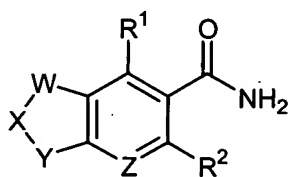
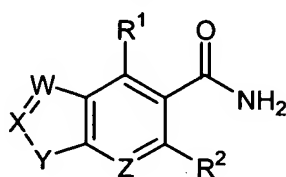
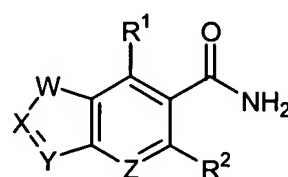
with a compound of the formula R<sup>5</sup>-N=C=O under conditions sufficient to produce a compound of Formula I, Formula II, or Formula III, where R<sup>3</sup> and R<sup>4</sup> are both H; or

- (b) optionally, contacting a compound of Formula Ic, Formula IIc, or Formula IIIc:

**Ic****IIc****IIIc**

where X is halogen, nitro, -CN, or -OR<sup>9</sup>, with a compound of the formula R<sup>1</sup>-H under conditions sufficient to produce a compound of Formula I, Formula II, or Formula III; or

- (c) contacting a compound of Formula Ib, Formula IIb, or Formula IIIb:

**Ib****IIb****IIIb**

with a haloformylation reagent and a compound of the formula  $R^4R^5NH$  under conditions sufficient to produce a compound of Formula I, Formula II, or Formula III, where  $R^4$  is H; or

- (d) elaborating substituents of a compound of Formula I, Formula II, or Formula III in a manner known *per se*; or
- (e) reacting the free base of a compound of Formula I, Formula II, or Formula III with an acid to give a pharmaceutically acceptable addition salt; or
- (f) reacting an acid addition salt of a compound of Formula I, Formula II, or Formula III with a base to form the corresponding free base; or
- (g) converting a salt of a compound of Formula I, Formula II, or Formula III to another pharmaceutically acceptable salt of a compound of Formula I, Formula II, or Formula III; or
- (h) resolving a racemic mixture of any proportions of a compound of Formula I, Formula II, or Formula III to yield a stereoisomer thereof.

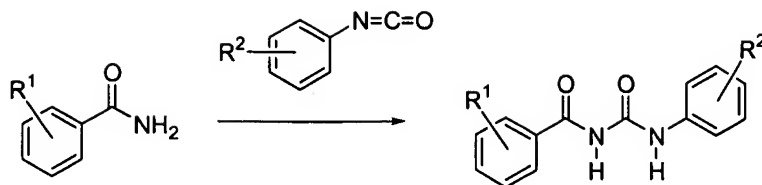
[0128] Step (a), above, may be carried out in the presence of an organic solvent or a mixture of solvents at elevated temperatures. Said organic solvent may be toluene, and the reaction may be carried out under refluxing conditions.

[0129] Step (b), above, may be carried out using the salt of the compound of the Formula  $R^1-H$  in an inorganic solvent. Said salt may be the lithium, sodium, or potassium salt.

[0130] Step (c), above, may be carried out in an organic solvent or a mixture of solvents at elevated temperatures. The haloformylation reagent may be a compound of the formula  $A-(CO)-B$  where A and B are, independently, suitable leaving groups such as halogens,  $-COCl$ ,  $-COBr$  and the like. The haloformylation agent and organic solvent employed in step (c) may be oxalyl chloride and THF, respectively, and the ensuing reaction may be heated to above  $50^\circ C$ .

[0131] The compounds of the invention can further be synthesized as shown in the following examples. These examples are merely illustrative of some methods by which the compounds of this invention can be synthesized, and various modifications to these examples can be made and will be suggested to a person of ordinary skill in the art having regard to this disclosure.

## Procedure A

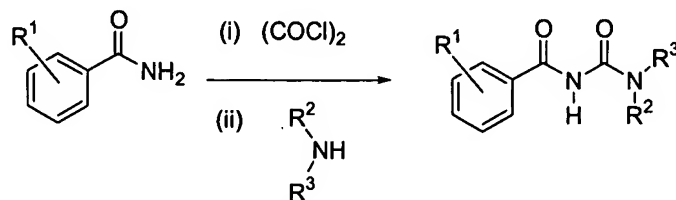


[0132] Acylurea compounds of the present invention may be prepared starting with an aryl carboxamide and an isocyanate. Carboxamide and isocyanate starting materials may be purchased from various different commercial sources, such as, for example the Aldrich Chemical Company, *supra*, or they may be prepared from standard procedures known in the art for preparing these compounds, such as the procedures described in the above-cited references. The isocyanates may also be prepared according to the procedures described in the example below. Typically, an aryl carboxamide is treated with an aryl isocyanate in an organic solvent or mixtures of suitable organic solvents. Preferably, the organic solvent is toluene. The carboxamide and the isocyanate may be combined as solutions or suspensions, depending on the solubilities of the compounds in the selected solvent. The carboxamide and the isocyanate may be added in a stoichiometric ratio (1:1), or a slight excess of the isocyanate may be used, for example between 1.01 fold and 2 fold excess, but typically about 1.01 to about 1.2 fold excess. Typically, the isocyanate is added to a suspension of the carboxamide in toluene, and the resulting mixture is heated until the reaction is determined to be complete. The reaction mixture may be heated at about 10 °C to about 150 °C, preferably at about 40 °C to about 120 °C under an inert atmosphere such as nitrogen, or the reaction mixture may be maintained at the refluxing temperature of the mixture. The reaction may be allowed to proceed to completion in about 10 minutes to 24 hours. Preferably, the reaction is heated to reflux until the reaction is complete, over about 6 to 24 hours.

[0133] Upon cooling of the reaction mixture, the resulting precipitated acylureas may be isolated by conventional techniques. Typically, the product is isolated by filtration. The precipitated solid may be filtered, washed with a solvent or a series of solvents, and isolated without further purification. Preferably, the precipitated acylureas may be washed with a combination of toluene, methanol and then with ether, and the product may be dried under vacuum. If desired, the acylureas may be further purified using conventional techniques, such as by crystallization using conventional

methods known in the art. Optionally, acylureas prepared according to this procedure may be converted to the corresponding salts prior to isolation and/or purification, or after crystallization.

#### Procedure B

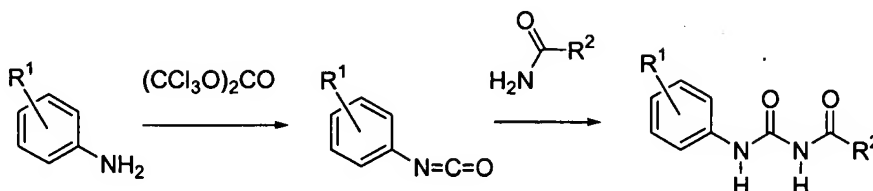


[0134] Acylureas may also be prepared from the condensation of an aryl carboxamide with an amine. The carboxamide may be prepared from the corresponding carboxylic acid or may be obtained from commercial sources. Depending on the desired substitution of the amine, optionally, the amine may be substituted where one substituted group is an amine protecting group such that the protecting group may be removed in a subsequent step if desired. In the first step of the process, a carboxamide mixture in a suitable aprotic solvent is treated with a haloformylation reagent to form the corresponding carboxamide carbonylchloride derivative. Typically, the aprotic solvent is dichloromethane, toluene, 2-methyltetrahydrofuran or THF, and the haloformylation reagent is oxalyl chloride. Preferably, the aprotic solvent is THF. Oxalyl chloride is preferably present in an excess, for example between 1.1 to 3.0 equivalents, typically about 1.5 equivalent over the carboxamide. The reaction is generally performed under an inert atmosphere where the mixture is heated to 50 °C to 175 °C for 15 minutes to 24 hours until the reaction is deemed complete. Typically, the reaction is heated to reflux over 2 to 16 hours under nitrogen, and then cooled to room temperature. The solvent is removed *in vacuo* by rotoevaporation or distillation, and the resulting carboxamide carbonylchloride is then condensed with a primary or secondary amine. Condensation with the amine may be performed by the addition of a solution of the amine in an aprotic solvent, such as THF, under an inert atmosphere, at a temperature between 0 °C and 20 °C, preferably between 0 °C and 5 °C. If the chloroformylation and the subsequent condensation reaction is performed in the same solvent, the solvent removal step may be eliminated. Preferably, the reaction is performed at 0 °C to 5 °C for 1 to 24 hours, until the reaction is complete. The solvent is removed by concentration under reduced pressure, and the acylurea can be isolated by



conventional techniques such as filtration and washing of the crude product with a solvent, followed by drying under vacuum.

#### Procedure C

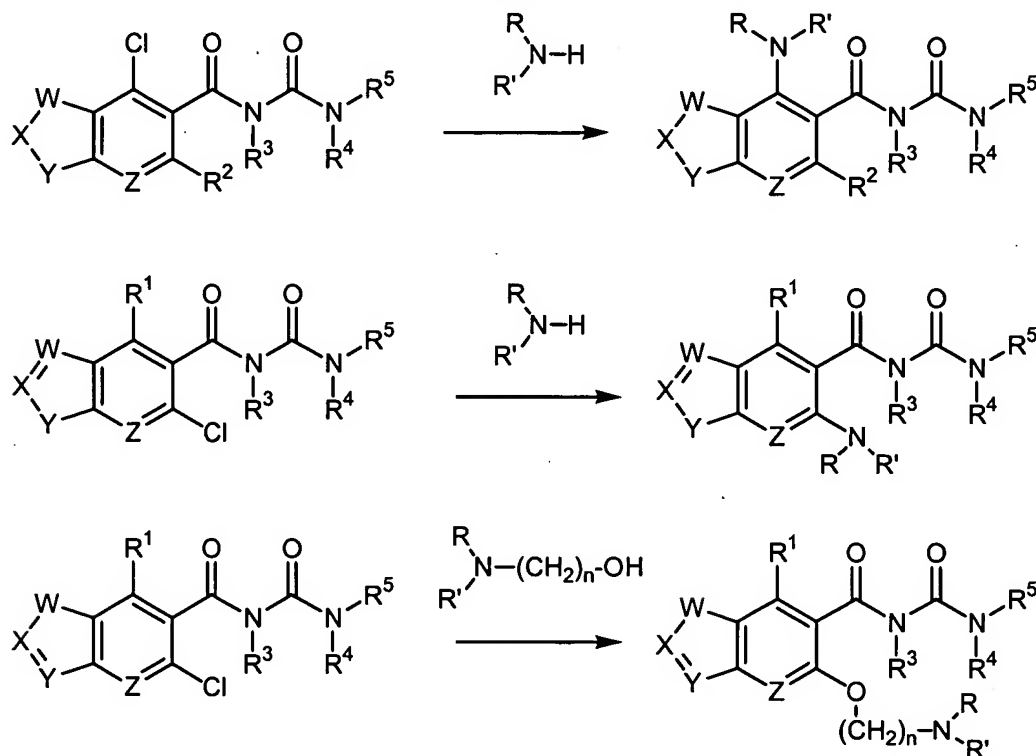


[0135] The preparation of the acylureas may also be performed starting with an amine or aniline derivative through a condensation reaction with a phosgene equivalent, followed by a condensation reaction with the carboxamide. Typically, a solution of an aniline or aniline derivative and triphosgene in tetrachloroethane or other suitable organic solvent is combined and stirred at 25 °C to 80 °C under an inert atmosphere for 2 to 12 hours until the reaction is complete. The solvent is removed under reduced pressure and the residue is dissolved in an aprotic solvent, such as toluene, and the resulting mixture is treated with a carboxamide. The mixture is heated to about 50 °C to 150 °C, preferably from about 75 °C to 115 °C. Preferably, the reaction mixture is heated to reflux for 2 to 24 hours until the reaction is complete, and allowed to cool to room temperature. The precipitated solid is isolated by conventional techniques such as filtration. The filtered solid is then washed with a suitable solvent or mixtures of solvents. Typically, the solid is washed with toluene, methanol and then ether, and the washed product is dried *in vacuo* to give the corresponding acylurea.

#### Procedure D

[0136] Amino or oxy-substituted aryl acyl ureas of the present invention may be prepared starting from the corresponding aryl halide acyl urea by the reaction of the aryl halide with an amine or alcohol. Preferably, the aryl halide is an aryl chloride, which can be prepared from one or more of the above described procedures or from standard procedures known in the art for preparing these compounds. Typically, the acyl urea is dissolved in an organic solvent or a mixture of suitable organic solvents. Preferably, the organic solvent is tetrahydrofuran. The acyl urea and the amine or

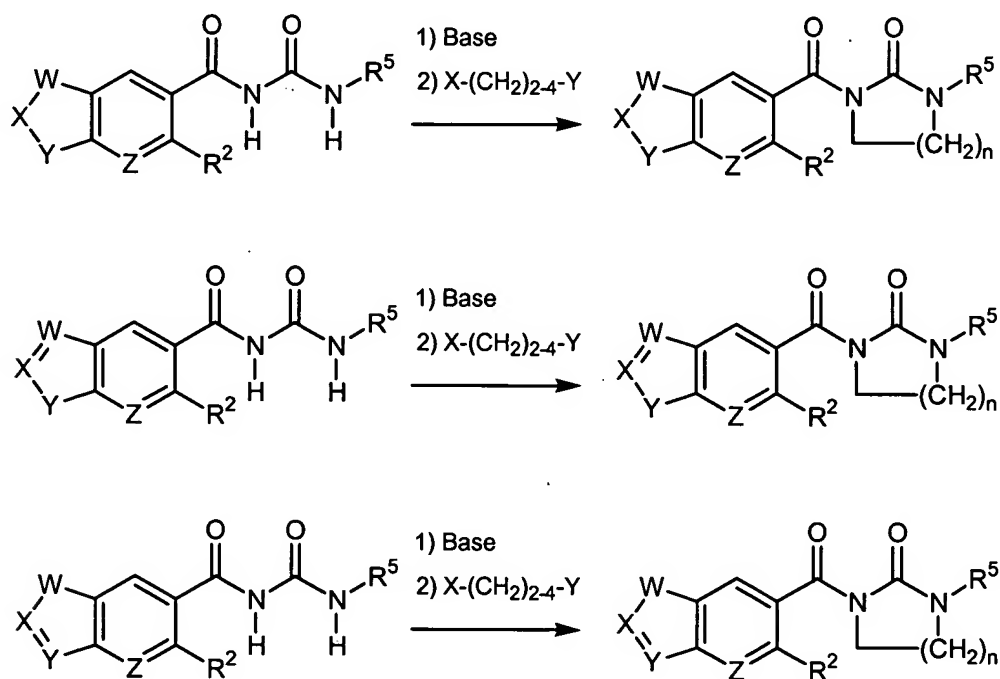
the alcohol may be combined as solutions or suspensions, depending on the solubilities of the compounds in the selected solvent or solvent mixtures.



[0137] The acyl urea and the amine or alcohol may be added in a stoichiometric ratio (1:1), or a slight excess of the amine or alcohol may be used, for example, between 1.01 fold and 20 fold excess, but typically about 1.01 to about 10 fold excess. Typically, the amine or alcohol is added to the acyl urea in tetrahydrofuran and the resulting mixture is stirred at about 0 °C to refluxing temperatures of the solvent, preferably at about 10 °C to about 50 °C, most preferably at about room temperatures under an inert atmosphere such as nitrogen. The reaction mixture is maintained at the reaction temperature until the reaction proceeds to completion. The reaction may be allowed to proceed to completion in about 10 minutes to 48 hours. Preferably, the reaction is stirred at room temperature for about 5 hours. When the reaction is deemed complete, the resulting product may be isolated by conventional techniques. Typically, the solvent and excess amine or alcohol may be removed by evaporation under reduced pressure, and the residue is suspended in a solvent. Preferably, the solvent is water. The suspension or solid may be filtered and washed with water or a suitable solvent, and then isolated and dried using conventional methods.

## Procedure E

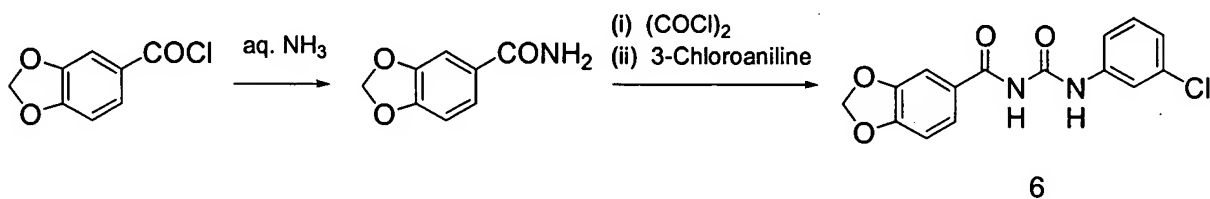
[0138] Cyclic acyl ureas of the present invention may be prepared according to methods known in the art. One method comprises the alkylation of the acyl urea nitrogens with an alkylating agent generically represented above as  $X-(CH_2)_{2-4}-Y$ , where X and Y are leaving groups, and may be the same or different. Leaving groups known in the art include halides, methanesulfonates, trifluoromethanesulfonates, p-toluenesulfonates, p-bromotoluenesulfonate, p-nitrobenzenesulfonates and the like. Representative alkylating agents include 1,2-dibromoethane, 1,3-dibromoethane, 1,3-dibromopropane, and the corresponding sulfonates and mixed halosulfonates.



[0139] Typically, the acyl urea is treated with a base in an organic solvent or mixtures of solvents. Preferably, the base is an inorganic base such as sodium hydride, or an organic base such as dimethyl sulfoxide and sodium hydride. Preferably, the solvent is a polar, aprotic solvent such as tetrahydrofuran, dimethylformamide, dimethyl sulfoxide, glycols, or mixtures of such solvents. Typically, a solution or suspension of the acyl urea is slowly added to the base in an organic solvent at about 0 °C to about 25 °C, and the resulting mixture is stirred for about 10 minutes to about 5 hours, preferably about 30 minutes. The alkylating agent is added and the mixture is stirred until the reaction is deemed complete. Alkylation of both urea nitrogens may be accomplished in a single step, or may be accomplished sequentially in a two step procedure by exposing the partially alkylated

product with the same or different base. The reaction is then quenched with a solvent, preferably water, and the mixture is extracted multiple times with an organic solvent. Preferably, the extracting solvent is dichloromethane. The combined organic extracts are washed with water, dried over anhydrous magnesium sulfate and concentrated under reduced pressure to afford the product, which may be purified using standard conditions known in the art. Purification may be performed by silica gel chromatography in a mixture of organic solvents, such as ethyl acetate and petroleum ether.

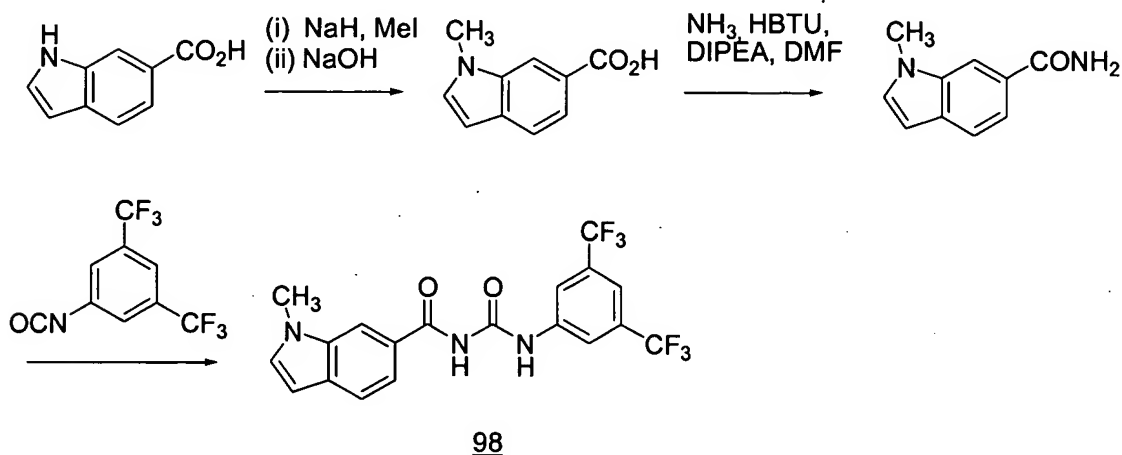
Example 1: 2H-Benzo[d]1,3-dioxolan-5-yl-*N*-{[(3-chlorophenyl)amino]carbonyl} carboxamide (6)



[0140] Piperonyl chloride (3.02 g) was cooled in an ice bath and treated with 28-30% aqueous ammonia (30 mL). The ice bath was removed and the mixture stirred at room temperature for 1 h. The solid was collected by filtration, washed with water and dried under high vacuum to yield 2H-benzo[d]1,3-dioxolane-5-carboxamide. A portion of this material (0.40 g) was suspended in anhydrous dichloromethane (6 mL) under a nitrogen atmosphere and treated with oxalyl chloride (1.8 mL of a 2M solution in dichloromethane). The mixture was heated at gentle reflux for 16 h and then cooled to room temperature. The solvent was removed under reduced pressure and the residue dissolved in anhydrous tetrahydrofuran (7.5 mL). An aliquot of this solution (2.5 mL) was added to an ice-cooled, stirred solution of 3-chloroaniline (85  $\mu$ L) in anhydrous tetrahydrofuran (1 mL). The ice-bath was removed and the mixture stirred at room temperature for 2 h. The precipitated solid was collected by filtration, washed with dichloromethane, and dried under high vacuum to give the title compound.

$^1\text{H}$  NMR (DMSO- $d_6$ )  $\delta$  6.16 (s, 2H), 7.06 (d, 1H,  $J=8.2$  Hz), 7.15 (d, 1H,  $J=7.8$  Hz), 7.35 (t, 1H,  $J=8.0$  Hz), 7.44 (d, 1H,  $J=8.3$  Hz), 7.59 (d, 1H,  $J=1.6$  Hz), 7.67 (d, 1H,  $J=8.2$  Hz), 7.83 (d, 1H,  $J=2.0$  Hz), 10.93 (s, 1H), 10.95 (s, 1H). MS (ESI)  $m/z$  317, 319.

**Example 2: N-({[3,5-bis(Trifluoromethyl)phenyl]amino}carbonyl)(1-methylindol-6-yl)carboxamide (98)**

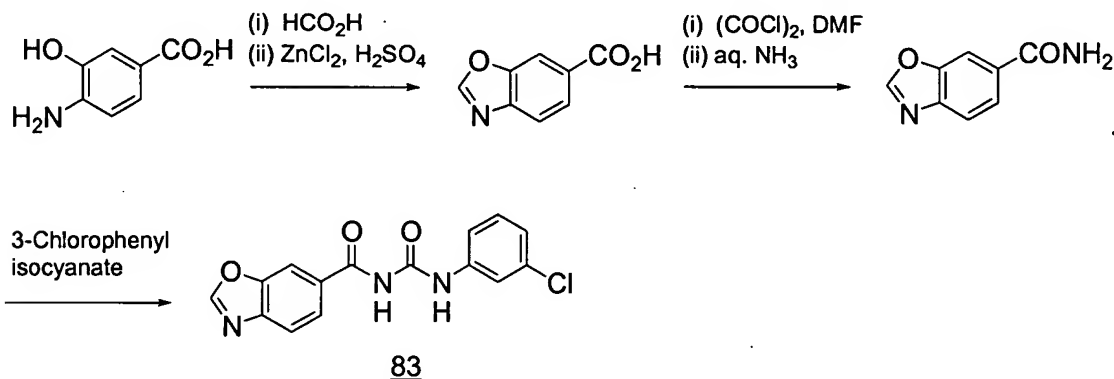


[0141] Sodium hydride (0.77 g of a 60% suspension in mineral oil) was washed with anhydrous hexane (2x10 mL) under a nitrogen atmosphere and then suspended in anhydrous *N,N*-dimethylformamide (DMF, 30 mL). A solution of indole-6-carboxylic acid (1.01 g) in DMF (20 mL) was added over 5 min and the solution stirred at room temperature for an additional 30 min. Iodomethane (1.2 mL) was added and the mixture stirred for 1 h. The solution was poured onto ice and allowed to warm up to room temperature. The resulting solid was collected by filtration, washed with water and dried under high vacuum to afford methyl 1-methylindole-6-carboxylate. A portion of this material (0.33 g) was dissolved in methanol (7 mL) and DMF (1 mL) and treated with 5N aqueous sodium hydroxide solution (2 mL). The mixture was heated at reflux for 22 h and then allowed to cool to ambient temperature. The solvent was evaporated under reduced pressure. The residue was dissolved in water (15 mL) and the solution was cooled in an ice-bath and acidified to pH 4 with concentrated HCl. The precipitated solid was collected by filtration, washed with water and dried under high vacuum to produce 1-methylindole-6-carboxylic acid. A portion of this material (0.27 g) was dissolved in DMF (4 mL), and treated with diisopropylethylamine (1.6 mL) and ammonia (12 mL of a 0.5M solution in dioxane) under a nitrogen atmosphere. *O*-Benzotriazol-*N,N,N',N'*-tetramethyluronium hexafluorophosphate (0.64 g) was added and the mixture stirred at room temperature for 20 h. The solvent was removed under reduced pressure. The residue was dissolved in ethyl acetate (50 mL), and the solution washed with water, 1M sodium carbonate solution, and brine, and dried over magnesium sulfate. Evaporation of

the solvent under reduced pressure produced 1-methylindole-6-carboxamide as an off-white solid. A portion of this material (0.04 g) was suspended in anhydrous toluene (1.0 mL) under a nitrogen atmosphere, and treated with 3,5-bis(trifluoromethyl)phenyl isocyanate (42  $\mu$ L). The mixture was heated at reflux for 2 h and then allowed to cool to room temperature. The solid was collected by filtration, washed with petroleum ether, dichloromethane and methanol and dried under high vacuum to yield the title compound.

$^1\text{H}$  NMR (DMSO- $d_6$ )  $\delta$  3.91 (s, 3H), 6.55 (d, 1H,  $J=2.9$  Hz), 7.62 (d, 1H,  $J=3.0$  Hz), 7.67 (d, 1H,  $J=8.4$  Hz), 7.73 (d, 1H,  $J=8.4$  Hz), 7.82 (s, 1H), 8.40 (br. s, 3H), 11.14 (br. s, 1H), 11.44 (s, 1H). MS (ESI)  $m/z$  428.

**Example 3: Benzoxazol-6-yl-N-[[ (3-chlorophenyl)amino]carbonyl]carboxamide (83)**



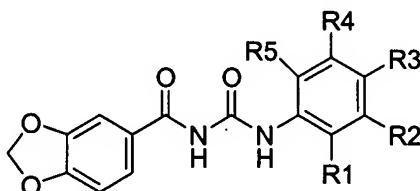
[0142] A solution of 4-amino-3-hydroxybenzoic acid (10.0 g) in 85% formic acid (60 mL) was heated at reflux for 3 h and then cooled to room temperature. The precipitated solid was filtered, washed with methanol, and dried under vacuum to produce 4-carboxylamino-3-hydroxybenzoic acid. A portion of this material (1.00 g) and zinc chloride (3.76 g) were suspended in *m*-xylene (135 L), and treated with 2 drops of concentrated sulfuric acid. The reaction mixture was azeotroped for 8 h, cooled to room temperature, and treated with water (20 mL). The resulting solid was collected by filtration, washed with water, and dried under high vacuum to afford benzoxazole-6-carboxylic acid. A portion of this material (0.80 g) was suspended in anhydrous dichloromethane (30 mL) under a nitrogen atmosphere and treated with oxalyl chloride (12.3 mL of a 2M solution in dichloromethane) and 1 drop of DMF. This suspension was stirred at room temperature for 16 h. The solvent was evaporated under reduced pressure. The residue was suspended in dichloromethane (20 mL) and poured into an ice-cold 2M solution of ammonia in methanol (122 mL). The mixture

was stirred at 0 °C for 1 h, and concentrated under reduced pressure. The solid residue was washed with dichloromethane and water, and dried under high vacuum to afford benzoxazole-6-carboxamide. A portion of this material (80 mg) was dried by azeotropic distillation with toluene (5.3 mL) and treated with 3-chlorophenyl isocyanate (83.3 mg). The mixture was heated at reflux for 6 h, allowed to cool to room temperature, and treated with methanol (5 mL). The precipitated solid was collected by filtration, washed with methanol and dichloromethane, and dried under high vacuum to yield the title compound. <sup>1</sup>H NMR (DMSO-d<sub>6</sub>) δ 7.18 (d, 1H, J=8.0 Hz), 7.39 (t, 1H, J=8.0 Hz), 7.49 (d, 1H, J=8.0 Hz), 7.86 (d, 1H, J=1.6 Hz), 7.97 (d, 1H, J=8.4 Hz), 8.09 (dd, 1H, J=8.4, 1.6 Hz), 8.50 (s, 1H), 8.98 (s, 1H), 10.90 (s, 1H), 11.24 (s, 1H). MS (ESI) m/z 314, 316.

### Compounds of General Formulae Ia, IIa, and IIIa

[0143] The compounds shown in Tables 1 to 11 were prepared either by the procedures described above or by modifications of these procedures familiar to those skilled in the art.

Table 1



Cmpd #	R <sup>1</sup>	R <sup>2</sup>	R <sup>3</sup>	R <sup>4</sup>	R <sup>5</sup>	MW	MS (m/z)
1	H	Cl	OH	H	H	334.71	333
2	H	Cl	Cl	H	H	353.16	351, 353
3	i-Pr	H	H	H	i-Pr	368.43	367
4	H	H	OH	H	H	300.28	299
5	H	Cl	OMe	H	H	348.74	347
6	H	Cl	H	H	H	318.71	317
7	H	H	H	H	H	284.27	283
8	OH	H	H	Cl	H	334.71	333, 335

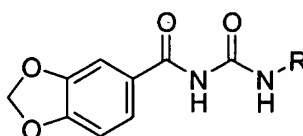
Cmpd #	R <sup>1</sup>	R <sup>2</sup>	R <sup>3</sup>	R <sup>4</sup>	R <sup>5</sup>	MW	MS (m/z)
9	H	F	H	H	H	302.26	301
10	F	H	H	H	F	320.25	319
11	F	F	H	H	H	320.25	319
12	H	H	F	H	H	302.26	301
13	H	H	Cl	H	H	318.71	317
14	H	F	F	H	H	320.25	319
15	H	H	CF <sub>3</sub>	H	H	352.27	371
16	H	CF <sub>3</sub>	H	H	H	352.27	351
17	H	H	NO <sub>2</sub>	H	H	329.27	328
18	H	CF <sub>3</sub>	NO <sub>2</sub>	H	H	397.26	396
19	H	CF <sub>3</sub>	Cl	H	H	386.71	385, 387
20	H	H	Br	H	H	363.17	361, 363
21	H	Br	H	H	H	363.17	361, 363
22	H	CN	H	H	H	309.30	308
23	Cl	H	Cl	H	H	353.16	351, 353
24	H	H	OMe	H	H	314.30	313
25	H	H	I	H	H	410.17	409
26	H	I	H	H	H	410.17	409
27	H	H	CONH <sub>2</sub>	H	H	327.29	327
28	H	F	CF <sub>3</sub>	H	H	370.26	369
29	H	CF <sub>3</sub>	F	H	H	370.26	369
30	H	H	Ph	H	H	360.37	359
31	H	OCF <sub>3</sub>	H	H	H	368.27	367



Cmpd #	R <sup>1</sup>	R <sup>2</sup>	R <sup>3</sup>	R <sup>4</sup>	R <sup>5</sup>	MW	MS (m/z)
32	H	SCF <sub>3</sub>	H	H	H	384.33	383
33	H	CF <sub>3</sub>	H	CF <sub>3</sub>	H	420.26	419
34	H	i-Pr	H	H	H	360.37	360
35	H	Et	H	H	H	312.32	311
36	H	OEt	H	H	H	328.32	327
37	H	Oi-Pr	H	H	H	342.35	341
38	H	t-Bu	H	H	H	340.38	339
39	H	Ph	H	H	H	360.37	359
40	H	Cl	Me	H	H	332.74	331, 333
41	H	I	Me	H	H	424.19	423
42	H	CF <sub>3</sub>	Me	H	H	366.29	365
43	H	OPh	H	H	H	376.37	375
44	H	NO <sub>2</sub>	H	H	H	329.27	328
45	H	Cl	H	Cl	H	353.16	351, 353
46	H	Ac	H	H	H	326.30	325
47	H	CO <sub>2</sub> Me	H	H	H	342.31	341
48	H	1H-1,2,3,4-tetrazol-5-yl	H	H	H	325.31	351
49	H	ethynyl	H	H	H	308.29	307
50	Me	Cl	H	H	H	332.74	351
51	Me	H	H	Cl	H	332.74	331
52	Et	Cl	H	H	Et	374.82	373
53	Me	H	H	I	H	424.19	423

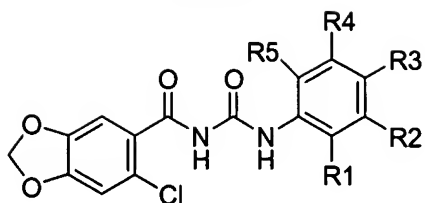
Cmpd #	R <sup>1</sup>	R <sup>2</sup>	R <sup>3</sup>	R <sup>4</sup>	R <sup>5</sup>	MW	MS (m/z)
54	H	2-pyridyl	H	H	H	361.36	362
55	H	1,3-thiazol-2-yl	H	H	H	367.38	368
56	H	3-thienyl	H	H	H	366.40	365
57	H	2-furyl	H	H	H	350.33	349
58	H	2-thienyl	H	H	H	366.40	365

Table 2



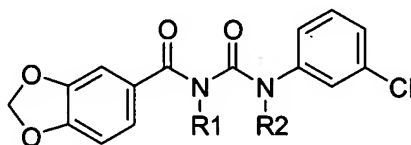
Cmpd #	R	MW	MS (m/z)
59	3,4-Methylenedioxyphenyl	328.28	327
60	5-Trifluoromethyl-1,2,3-thiadiazol-2-yl	360.27	359
61	5-Chloro-1,3-thiazol-2-yl	325.73	324, 326
62	6-Chloro-4-methylpyrimidin-2-yl	334.72	333, 335
63	2-Chloro-4-pyridyl	319.70	318, 320

Table 3



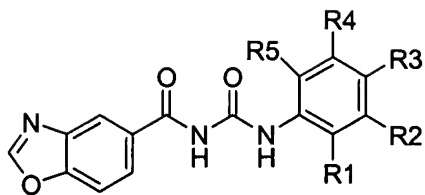
Cmpd #	R <sup>1</sup>	R <sup>2</sup>	R <sup>3</sup>	R <sup>4</sup>	R <sup>5</sup>	MW	MS (m/z)
64	H	CN	H	H	H	343.73	342
65	H	I	H	H	H	444.61	443
66	H	CF <sub>3</sub>	H	H	H	386.71	385
67	H	Oi-Pr	H	H	H	376.79	375
68	H	CF <sub>3</sub>	F	H	H	404.70	403

Table 4



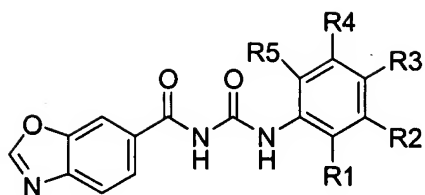
Cmpd #	R <sup>1</sup>	R <sup>2</sup>	MW	MS (m/z)
69	Me	Me	346.77	347, 349
70	Me	H	332.74	ND

Table 5



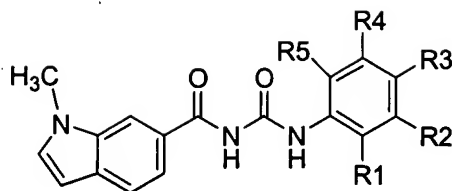
Cmpd #	R <sup>1</sup>	R <sup>2</sup>	R <sup>3</sup>	R <sup>4</sup>	R <sup>5</sup>	MW	MS (m/z)
71	H	Cl	Cl	H	H	350.16	348, 350
72	H	H	Cl	H	H	315.72	314
73	H	Cl	H	H	H	315.72	314
73	H	Br	H	H	H	360.17	358, 360
75	H	H	CF <sub>3</sub>	H	H	349.27	348
76	H	I	H	H	H	407.16	406
77	H	CF <sub>3</sub>	H	H	H	349.27	348
78	H	CF <sub>3</sub>	H	CF <sub>3</sub>	H	417.26	418
79	H	H	F	H	H	299.26	298

Table 6



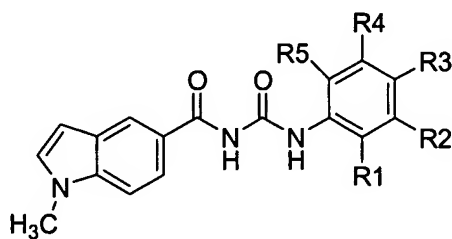
Cmpd #	R <sup>1</sup>	R <sup>2</sup>	R <sup>3</sup>	R <sup>4</sup>	R <sup>5</sup>	MW	MS (m/z)
80	H	Cl	Cl	H	H	350.16	348, 350
81	H	H	Cl	H	H	315.72	314
82	H	H	CF <sub>3</sub>	H	H	349.27	348
83	H	Cl	H	H	H	315.72	314
84	H	CF <sub>3</sub>	H	H	H	349.27	348
85	H	CF <sub>3</sub>	H	CF <sub>3</sub>	H	417.26	417
86	H	OCF <sub>3</sub>	H	H	H	365.27	364
87	H	CN	H	H	H	306.28	305
88	H	CF <sub>3</sub>	F	H	H	367.26	366
89	H	Br	H	H	H	360.17	358
90	H	CO <sub>2</sub> CH <sub>3</sub>	H	H	H	339.30	338
91	H	Cl	CO <sub>2</sub> H	H	H	359.72	358
92	H	Cl	OCH <sub>2</sub> CO <sub>2</sub> - CH <sub>2</sub> Ph	H	H	479.87	478
93	H	H	CO <sub>2</sub> H	H	H	325.27	324
94	H	CO <sub>2</sub> H	Cl	H	H	359.72	358
95	H	Cl	CO <sub>2</sub> Na	H	H	381.70	358
96	H	CO <sub>2</sub> Na	Cl	H	H	381.70	358
97	H	H	CO <sub>2</sub> Na	H	H	347.25	ND

Table 7



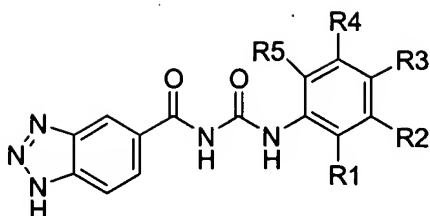
Cmpd #	R <sup>1</sup>	R <sup>2</sup>	R <sup>3</sup>	R <sup>4</sup>	R <sup>5</sup>	MW	MS (m/z)
98	H	CF <sub>3</sub>	H	CF <sub>3</sub>	H	429.32	428
99	H	CF <sub>3</sub>	H	H	H	361.32	360
100	H	Cl	Cl	H	H	362.21	360, 362, 364
101	H	I	H	H	H	419.22	418
102	H	CN	H	H	H	318.33	317
103	H	CF <sub>3</sub>	F	H	H	379.31	378

Table 8



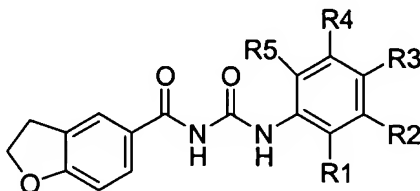
Cmpd #	R <sup>1</sup>	R <sup>2</sup>	R <sup>3</sup>	R <sup>4</sup>	R <sup>5</sup>	MW	MS (m/z)
104	H	Cl	Cl	H	H	362.21	360, 362, 364
105	H	Cl	H	H	H	327.77	326, 328
106	H	Br	H	H	H	372.22	370, 372
107	H	CF <sub>3</sub>	H	CF <sub>3</sub>	H	429.32	428
108	H	CF <sub>3</sub>	F	H	H	379.31	378

Table 9



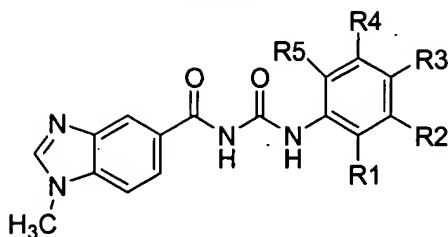
Cmpd #	R <sup>1</sup>	R <sup>2</sup>	R <sup>3</sup>	R <sup>4</sup>	R <sup>5</sup>	MW	MS (m/z)
109	H	Cl	Cl	H	H	350.16	348, 350
110	H	H	Cl	H	H	315.72	314

Table 10



Cmpd #	R <sup>1</sup>	R <sup>2</sup>	R <sup>3</sup>	R <sup>4</sup>	R <sup>5</sup>	MW	MS (m/z)
111	H	Cl	Cl	H	H	351.19	349, 351, 353
112	H	Cl	H	H	H	316.74	315, 317
113	H	H	CF <sub>3</sub>	H	H	350.29	349
114	H	H	F	H	H	300.29	299
115	H	H	OMe	H	H	312.32	311

Table 11



Cmpd #	R <sup>1</sup>	R <sup>2</sup>	R <sup>3</sup>	R <sup>4</sup>	R <sup>5</sup>	Form	MW	MS (m/z)
116	H	Cl	Cl	H	H	Free base	363.20	361, 363
117	H	Cl	Cl	H	H	HCl salt	399.66	361, 363

[0144] The names of the compounds shown in Tables 1 to 11 are given in Table 12. These names were generated with the Chemistry 4-D Draw™ software from ChemInnovation Software, Inc. (San Diego, CA).

Table 12

Cmpd #	IUPAC Name
1	2H-Benzo[d]1,3-dioxolan-5-yl-N-{[(3-chloro-4-hydroxyphenyl)amino]carbonyl}carboxamide
2	2H-Benzo[d]1,3-dioxolan-5-yl-N-{[(3,4-dichlorophenyl)amino]carbonyl}carboxamide
3	2H-Benzo[d]1,3-dioxolan-5-yl-N-{[2,6-bis(methylethyl)phenyl]amino}carbonyl}carboxamide
4	2H-Benzo[d]1,3-dioxolan-5-yl-N-{[(4-hydroxyphenyl)amino]carbonyl}carboxamide
5	2H-Benzo[d]1,3-dioxolan-5-yl-N-{[(3-chloro-4-methoxyphenyl)amino]carbonyl}carboxamide
6	2H-Benzo[d]1,3-dioxolan-5-yl-N-{[(3-chlorophenyl)amino]carbonyl}carboxamide
7	2H-Benzo[d]1,3-dioxolan-5-yl-N-[(phenylamino)carbonyl]carboxamide
8	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N-{[(5-chloro-2-hydroxyphenyl)amino]carbonyl}-carboxamide
9	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N-{[(3-fluorophenyl)amino]carbonyl}carboxamide



Cmpd #	IUPAC Name
10	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N-{(2,6-difluorophenyl)amino}carbonyl} carboxamide
11	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N-{(2,3-difluorophenyl)amino}carbonyl} carboxamide
12	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N-{(4-fluorophenyl)amino}carbonyl} carboxamide
13	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N-{(4-chlorophenyl)amino}carbonyl} carboxamide
14	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N-{(3,4-difluorophenyl)amino}carbonyl} carboxamide
15	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N-({[4-(trifluoromethyl)phenyl]amino}carbonyl)-carboxamide
16	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N-({[3-(trifluoromethyl)phenyl]amino}carbonyl)-carboxamide
17	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N-{(4-nitrophenyl)amino}carbonyl} carboxamide
18	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N-({[4-nitro-3-(trifluoromethyl)phenyl]amino}carbonyl)-carboxamide
19	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N-({[4-chloro-3-(trifluoromethyl)phenyl]amino}carbonyl)-carboxamide
20	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N-{(4-bromophenyl)amino}carbonyl} carboxamide
21	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N-{(3-bromophenyl)amino}carbonyl} carboxamide
22	2H-Benzo[d]1,3-dioxolan-5-yl-N-{(3-cyanophenyl)amino}carbonyl} carboxamide
23	2H-Benzo[d]1,3-dioxolan-5-yl-N-{(2,4-dichlorophenyl)amino}carbonyl} carboxamide
24	2H-Benzo[d]1,3-dioxolan-5-yl-N-{(4-methoxyphenyl)amino}carbonyl} carboxamide
25	2H-Benzo[d]1,3-dioxolan-5-yl-N-{(4-iodophenyl)amino}carbonyl} carboxamide
26	2H-Benzo[d]1,3-dioxolan-5-yl-N-{(3-iodophenyl)amino}carbonyl} carboxamide
27	4- {[ (2H-Benzo[d]1,3-dioxolan-5-ylcarbonylamino)carbonyl]amino} benzamide
28	2H-Benzo[d]1,3-dioxolan-5-yl-N-({[3-fluoro-4-(trifluoromethyl)phenyl]amino}carbonyl)-carboxamide

Cmpd #	IUPAC Name
29	2H-Benzo[d]1,3-dioxolan-5-yl-N-({[4-fluoro-3-(trifluoromethyl)phenyl]amino}carbonyl)-carboxamide
30	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N-{{[4-phenylphenyl]amino}carbonyl}carboxamide
31	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N-({[3-(trifluoromethoxy)phenyl]amino}carbonyl)-carboxamide
32	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N-({[3-(trifluoromethylthio)phenyl]amino}carbonyl)-carboxamide
33	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N-({[3,5-bis(trifluoromethyl)phenyl]amino}carbonyl)-carboxamide
34	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N-({[3-(methylethyl)phenyl]amino}carbonyl)carboxamide
35	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N-{{[3-ethylphenyl]amino}carbonyl}carboxamide
36	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N-{{[3-ethoxyphenyl]amino}carbonyl}carboxamide
37	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N-({[3-(methylethoxy)phenyl]amino}carbonyl)carboxamide
38	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N-({[3-(tert-butyl)phenyl]amino}carbonyl)carboxamide
39	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N-{{[3-phenylphenyl]amino}carbonyl}carboxamide
40	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N-{{[3-chloro-4-methylphenyl]amino}carbonyl}carboxamide
41	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N-{{[3-iodo-4-methylphenyl]amino}carbonyl}carboxamide
42	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N-({[4-methyl-3-(trifluoromethyl)phenyl]amino}carbonyl)-carboxamide
43	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N-{{[3-phenoxyphenyl]amino}carbonyl}carboxamide
44	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N-{{[3-nitrophenyl]amino}carbonyl}carboxamide
45	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N-{{[3,5-dichlorophenyl]amino}carbonyl}carboxamide
46	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N-{{[3-acetylphenyl]amino}carbonyl}carboxamide
47	Methyl 3-{{[(2H-Benzo[3,4-d]1,3-dioxolen-5-ylcarbonylamino)carbonyl]amino}benzoate

Cmpd #	IUPAC Name
48	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N- {[ (3-(1H-1,2,3,4-tetraazol-5-yl)phenyl)amino]carbonyl}-carboxamide
49	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N- {[ (3-ethynylphenyl)amino]carbonyl} carboxamide
50	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N- {[ (3-chloro-2-methylphenyl)amino]carbonyl} carboxamide
51	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N- {[ (5-chloro-2-methylphenyl)amino]carbonyl} carboxamide
52	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N- {[ (3-chloro-2,6-diethylphenyl)amino]carbonyl}-carboxamide
53	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N- {[ (5-iodo-2-methylphenyl)amino]carbonyl} carboxamide
54	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N- {[ (3-(2-pyridyl)phenyl)amino]carbonyl} carboxamide
55	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N- {[ (3-(1,3-thiazol-2-yl)phenyl)amino]carbonyl}-carboxamide
56	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N- {[ (3-(3-thienyl)phenyl)amino]carbonyl} carboxamide
57	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N- {[ (3-(2-furyl)phenyl)amino]carbonyl} carboxamide
58	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N- {[ (3-(2-thienyl)phenyl)amino]carbonyl} carboxamide
59	2H-Benzo[d]1,3-dioxolan-5-yl-N- [(2H-Benzo[3,4-d]1,3-dioxolen-5-ylamino)carbonyl]-carboxamide
60	2H-Benzo[d]1,3-dioxolan-5-yl-N- {[ (5-(trifluoromethyl)(1,3,4-thiadiazol-2-yl))amino]carbonyl}-carboxamide
61	2H-Benzo[d]1,3-dioxolan-5-yl-N- {[ (5-chloro(1,3-thiazol-2-yl))amino]carbonyl} carboxamide
62	2H-Benzo[d]1,3-dioxolan-5-yl-N- {[ (6-chloro-4-methylpyrimidin-2-yl)amino]carbonyl}-carboxamide
63	2H-Benzo[d]1,3-dioxolan-5-yl-N- {[ (2-chloro(4-pyridyl))amino]carbonyl} carboxamide
64	(6-Chloro(2H-benzo[3,4-d]1,3-dioxolen-5-yl))-N- {[ (3-cyanophenyl)amino]carbonyl}-carboxamide
65	(6-Chloro(2H-benzo[3,4-d]1,3-dioxolen-5-yl))-N- {[ (3-iodophenyl)amino]carbonyl} carboxamide

Cmpd #	IUPAC Name
66	(6-Chloro(2H-benzo[3,4-d]1,3-dioxolen-5-yl))-N-([3-(trifluoromethyl)phenyl]amino)-carbonylcarboxamide
67	(6-Chloro(2H-benzo[3,4-d]1,3-dioxolen-5-yl))-N-([3-(methylethoxy)phenyl]amino)-carbonylcarboxamide
68	(6-Chloro(2H-benzo[3,4-d]1,3-dioxolen-5-yl))-N-([4-fluoro-3-(trifluoromethyl)phenyl]amino)-carbonylcarboxamide
69	2H-Benzo[3,4-d]1,3-dioxolen-5-yl-N-([(3-chlorophenyl)methylamino]carbonyl)-N-methylcarboxamide
70	2H-Benzo[d]1,3-dioxolan-5-yl-N-([(3-chlorophenyl)amino]carbonyl)-N-methylcarboxamide
71	Benzoxazol-5-yl-N-([(3,4-dichlorophenyl)amino]carbonyl)carboxamide
72	Benzoxazol-5-yl-N-([(4-chlorophenyl)amino]carbonyl)carboxamide
73	Benzoxazol-5-yl-N-([(3-chlorophenyl)amino]carbonyl)carboxamide
74	Benzoxazol-5-yl-N-([(3-bromophenyl)amino]carbonyl)carboxamide
75	Benzoxazol-5-yl-N-([4-(trifluoromethyl)phenyl]amino)-carbonylcarboxamide
76	Benzoxazol-5-yl-N-([(3-iodophenyl)amino]carbonyl)carboxamide
77	Benzoxazol-5-yl-N-([3-(trifluoromethyl)phenyl]amino)-carbonylcarboxamide
78	Benzoxazol-5-yl-N-([3,5-bis(trifluoromethyl)phenyl]amino)-carbonylcarboxamide
79	Benzoxazol-5-yl-N-([(4-fluorophenyl)amino]carbonyl)carboxamide
80	Benzoxazol-6-yl-N-([(3,4-dichlorophenyl)amino]carbonyl)carboxamide
81	Benzoxazol-6-yl-N-([(4-chlorophenyl)amino]carbonyl)carboxamide
82	Benzoxazol-6-yl-N-([4-(trifluoromethyl)phenyl]amino)-carbonylcarboxamide
83	Benzoxazol-6-yl-N-([(3-chlorophenyl)amino]carbonyl)carboxamide
84	Benzoxazol-6-yl-N-([3-(trifluoromethyl)phenyl]amino)-carbonylcarboxamide
85	Benzoxazol-6-yl-N-([3,5-bis(trifluoromethyl)phenyl]amino)-carbonylcarboxamide

Cmpd #	IUPAC Name
86	Benzoxazol-6-yl-N-([3-(trifluoromethoxy)phenyl]amino)carbonyl)carboxamide
87	Benzoxazol-6-yl-N-([3-cyanophenyl]amino)carbonyl)carboxamide
88	Benzoxazol-6-yl-N-([4-fluoro-3-(trifluoromethyl)phenyl]amino)carbonyl)carboxamide
89	Benzoxazol-6-yl-N-([3-bromophenyl]amino)carbonyl)carboxamide
90	Methyl 3-([[(benzoxazol-6-ylcarbonylamino)carbonyl]amino]benzoate
91	4-([[(benzoxazol-6-ylcarbonylamino)carbonyl]amino]-2-chlorobenzoic acid
92	Phenylmethyl 2-(4-([[(benzoxazol-6-ylcarbonylamino)carbonyl]amino]-2-chlorophenoxy)acetate
93	4-([[(benzoxazol-6-ylcarbonylamino)carbonyl]amino]benzoic acid
94	5-([[(benzoxazol-6-ylcarbonylamino)carbonyl]amino]-2-chlorobenzoic acid
95	Sodium 4-([[(benzoxazol-6-ylcarbonylamino)carbonyl]amino]-2-chlorobenzoate
96	Sodium 5-([[(benzoxazol-6-ylcarbonylamino)carbonyl]amino]-2-chlorobenzoate
97	Sodium 4-([[(benzoxazol-6-ylcarbonylamino)carbonyl]amino]benzoate
98	N-([3,5-bis(Trifluoromethyl)phenyl]amino)carbonyl)(1-methylindol-6-yl)carboxamide
99	(1-Methylindol-6-yl)-N-([3-(trifluoromethyl)phenyl]amino)carbonyl)carboxamide
100	N-([3,4-Dichlorophenyl]amino)carbonyl)(1-methylindol-6-yl)carboxamide
101	N-([3-Iodophenyl]amino)carbonyl)(1-methylindol-6-yl)carboxamide
102	N-([3-Cyanophenyl]amino)carbonyl)(1-methylindol-6-yl)carboxamide
103	N-([4-Fluoro-3-(trifluoromethyl)phenyl]amino)carbonyl)(1-methylindol-6-yl)carboxamide
104	N-([3,4-Dichlorophenyl]amino)carbonyl)(1-methylindol-5-yl)carboxamide
105	N-([3-Chlorophenyl]amino)carbonyl)(1-methylindol-5-yl)carboxamide
106	N-([3-Bromophenyl]amino)carbonyl)(1-methylindol-5-yl)carboxamide
107	N-([3,5-bis(Trifluoromethyl)phenyl]amino)carbonyl)(1-methylindol-5-yl)carboxamide

Cmpd #	IUPAC Name
108	N-({[4-Fluoro-3-(trifluoromethyl)phenyl]amino}carbonyl)(1-methylindol-5-yl)carboxamide
109	Benzotriazol-5-yl-N-{{[(3,4-dichlorophenyl)amino]carbonyl}carboxamide
110	Benzotriazol-5-yl-N-{{[(4-chlorophenyl)amino]carbonyl}carboxamide
111	N-{{[(3,4-Dichlorophenyl)amino]carbonyl}-2,3-dihydrobenzo[b]furan-5-ylcarboxamide
112	N-{{[(3-Chlorophenyl)amino]carbonyl}-2,3-dihydrobenzo[b]furan-5-ylcarboxamide
113	2,3-Dihydrobenzo[b]furan-5-yl-N-({[4-(trifluoromethyl)phenyl]amino}carbonyl)carboxamide
114	2,3-Dihydrobenzo[b]furan-5-yl-N-{{[(4-fluorophenyl)amino]carbonyl}carboxamide
115	2,3-Dihydrobenzo[b]furan-5-yl-N-{{[(4-methoxyphenyl)amino]carbonyl}carboxamide
116	N-{{[(3,4-Dichlorophenyl)amino]carbonyl}(1-methylbenzimidazol-5-yl)carboxamide
117	N-{{[(3,4-Dichlorophenyl)amino]carbonyl}(1-methylbenzimidazol-5-yl)carboxamide, hydrochloride

#### Example 4: Inhibition of MCP-1 Induced Chemotaxis

[0145] A 96 well microchemotaxis chamber with a 5  $\mu\text{m}$ -pore size, PVP-coated polycarbonate filter membrane (Neuro Probe Inc., Cabin John, MD) was used for testing. Compounds were prepared as 10 mM stock solution in DMSO. THP-1 cells ( $2 \times 10^6$  cells/mL) were labeled with 5  $\mu\text{M}$  Calcein AM containing 0.1% F127 (Molecular Probe, Eugene, OR) at 37 °C for 30 min, and then pretreated with compound at room temperature for an additional 30 min. The lower chamber was loaded with medium containing 12.5 nM hMCP-1. The filter membrane was placed over the lower chamber, followed by a silicon gasket and the upper chamber. The pretreated THP-1 cells ( $4 \times 10^5$  cells/50  $\mu\text{L}$  of RPMI1640 medium per well) were added to the upper chamber and incubated in 5%  $\text{CO}_2$  at 37 °C for 2 hr. The migrated cells were determined with a fluorescent plate reader (LJL BioSystems, Sunnyvale, CA). Table 13 shows the  $\text{IC}_{50}$  (concentration of compound that inhibited migration of 50% of the cells relative to control) for several compounds of the present invention.

Table 13. Effect of Selected Compounds on MCP-1 Induced Chemotaxis

Cmpd #	IC <sub>50</sub> (μM)	Cmpd #	IC <sub>50</sub> (μM)	Cmpd #	IC <sub>50</sub> (μM)
1	4.284	33	0.955	81	3.185
2	11.833	37	0.649	83	1.228
6	4.170	39	2.699	84	1.756
13	>100	54	0.438	86	0.362
16	0.760	55	0.203	87	4.629
19	13.302	56	0.658	88	1.720
21	3.640	57	10.158	89	1.207
22	3.093	58	3.668	98	1.353
23	5.904	65	8.051	100	0.598
25	11.661	71	0.857	101	0.536
26	0.198	74	3.674	102	4.488
29	29.296	75	>100	105	8.962
31	2.175	80	0.168	111	8.181

**Example 5: Thioglycollate-Induced Inflammation Model**

[0146] 3% Brewer's thioglycollate broth (Difco, Detroit, MI) was injected into the peritoneal cavity of ICR male mice, followed by subcutaneous administration of the same dose of test compound after 0 h, 3 h and 16 hours post-thioglycollate injection, respectively. After 96 h, the number of total elicited cells and MOMA2-positive cells in the peritoneal cavity was analyzed using a flowcytometer (EPICS XL, Beckman Coulter). The results are shown in Table 14.

Table 14. Effect of Selected Compounds on a Thioglycollate-Induced Inflammation Model

Compound	Dose (mg/kg)	Total Cells (x10 <sup>6</sup> )	MOMA2-positive Cells (x10 <sup>6</sup> )
No treatment	-	1.8 ± 0.3	1.7 ± 0.3

Control	-	13.6 ± 1.1	11.4 ± 0.8
16	10	8.8 ± 1.5	7.5 ± 1.6
82	10	4.2 ± 0.4	3.2 ± 0.4

Significant difference from control group: \*P < 0.05, \*\*P < 0.01 (ANOVA).

#### Example 6: Anti-Thy-1 Antibody Induced Nephritis Model

[0147] The efficacy of the compounds of the present invention was also evaluated in an animal model of nephritis. This model simulates very closely the conditions found in human mesangial proliferative glomerulonephritis.

[0148] Anti-Thy-1 nephritis was induced by intravenous injection of anti-Thy-1-antibody to male Wistar rats. The test compound was subcutaneously administered 2 h before, immediately after, and 5 h after the anti-Thy-1 antibody treatment, and then twice a day for the following 2 days. Anti-MCP-1 antibody was intraperitoneally injected once a day for 3 days. Seven days after the anti-Thy-1 antibody treatment, the rats were sacrificed. The kidneys were perfused with 10% formaldehyde in PBS, surgically removed, and immersed in 10% formaldehyde. The kidneys were then embedded in paraffin for glomerular histopathology or in OCT compound (Miles Inc., Elkhart, IN) in liquid nitrogen after immersion in 30% sucrose overnight. Immunohistochemical staining was performed with a mouse anti-rat ED-1 monoclonal antibody. Briefly, 5 mm renal sections were prepared and endogenous peroxidase blocked with 0.3% hydrogen peroxide. The sections were then blocked with Protein Block (DAKO, Japan) and stained with anti-ED-1 antibody for 45 min. The ED-1 antigen was visualized by peroxidase-labeled anti-mouse IgG and diaminobenzidine. The amount of urinary protein was determined with the DC protein assay kit (Bio-Rad, Hercules, CA). The effect of a representative test compound on the level of urinary protein excretion and the infiltration of ED-1 positive cells into the glomeruli is shown in Table 15.

Table 15. Effect of Compound 80 on Anti-Thy-1 Antibody Induced Nephritis

Compound	Dose (mg/kg)	Urinary Protein (mg/day)
No treatment	-	20.0 ± 3.0**



Control	-	194.2 ± 46.7
80	1	162.1 ± 42.6

Significant difference from control group: \*\*P < 0.01 (ANOVA).

**Example 7: Oral pharmaceutical composition - Solid dosage formulation**

[0149] A pharmaceutical composition for oral administration may be prepared by combining the following:

	<u>% w/w</u>
Compound of this invention	10.0
Magnesium stearate	0.5
Starch	2.0
(Hydroxypropyl)methylcellulose	1.0
Microcrystalline cellulose	86.5

[0150] The mixture may be compressed to tablets, or filled into hard gelatin capsules. The tablet may be coated by applying a suspension of film former (eg, (hydroxypropyl)methylcellulose), pigment (eg, titanium dioxide) and plasticiser (eg, diethyl phthalate) and drying the film by evaporation of the solvent. The film coat can comprise 2.0% to 6.0% of the tablet weight, preferably about 3.0%.

**Example 8: Oral pharmaceutical composition preparation - Capsule**

[0151] A pharmaceutical composition of a compound of the invention suitable for oral administration may also be prepared by combining the following:

	<u>% w/w</u>
Compound of this invention	20
Polyethylene glycol 400	80

[0152] The medicinal compound is dispersed or dissolved in the liquid carrier, with a thickening agent added, if required. The formulation is then enclosed in a soft gelatin capsule by suitable technology.

**Example 9: Pharmaceutical composition for parenteral administration**

[0153] A pharmaceutical composition for parenteral administration may be prepared by combining the following:

	<u>Preferred Level (%)</u>
Compound of this invention	1.0
Saline	99.0

The solution is sterilized and sealed in sterile containers.

[0154] Various modifications and variations of the present invention will be apparent to those skilled in the art without departing from the scope and spirit of the invention. Although the invention has been described in connection with specific preferred embodiments, it should be understood that the invention as disclosed should not be unduly limited to such specific embodiments. Various modifications of the described modes for carrying out the invention which are obvious to those skilled in the art are intended to be within the scope of this invention.